Luftwaffe Colours

1935-1945

Michael Ullmann

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Michael Ullmann

HIKOKI PUBLICATIONS

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ACKNOWLEDGMENTS

No-one will be in any doubt that a study of this scope and content cannot be created by one person only. I firmly believe that the subject with which this treatise is concerned can be tackled only by an international team since the relevant documents are scattered throughout the world. My recognition and thanks go first of all to my wife, Birgit, for her understanding for the time that we have both lost through the preparation of this work. I received technical support especially from Kenneth Merrick, from whom I obtained numerous copies of documents which are reflected in these pages. I should also like to thank Dr. Jürging and Mr Wigger of RAL, Mrs Resmini of the Wehrtechnische Studiensammlung, Dr Pomper and Mrs Koch, Mrs Burgmaier of the Dornier Company Archives, Mr Ebert, Olve Dybvig, David E. Brown, David Wadman and Tomas Poruba. Photos were kindly supplied through many sources apart from the author, including the Bundesarchiv, Philip Jafrett, Barry Ketley, Ken Merrick, Kees Mol, Simon Parry, Martin Pegg, Bruce Robertson, Sergio Luis dos Santos, Michael Schmeelke, Josef Schwarzecker, Josef Wachter, Richard L. Ward and Eduard Winkler.

2: An extract from the Handbook for the Dornier Do 217E

3. Anstrich und Beschriftung

a) Sichtschutzanstrich

Die Flugzeuge erhalten vollen Nachtschutzanstrich.

Den mehrfarbigen Sichtschutzanstrich eines Teiles der Flugzeuge mit Angabe der Farbtöne zeigt die anschließende Abbildung.

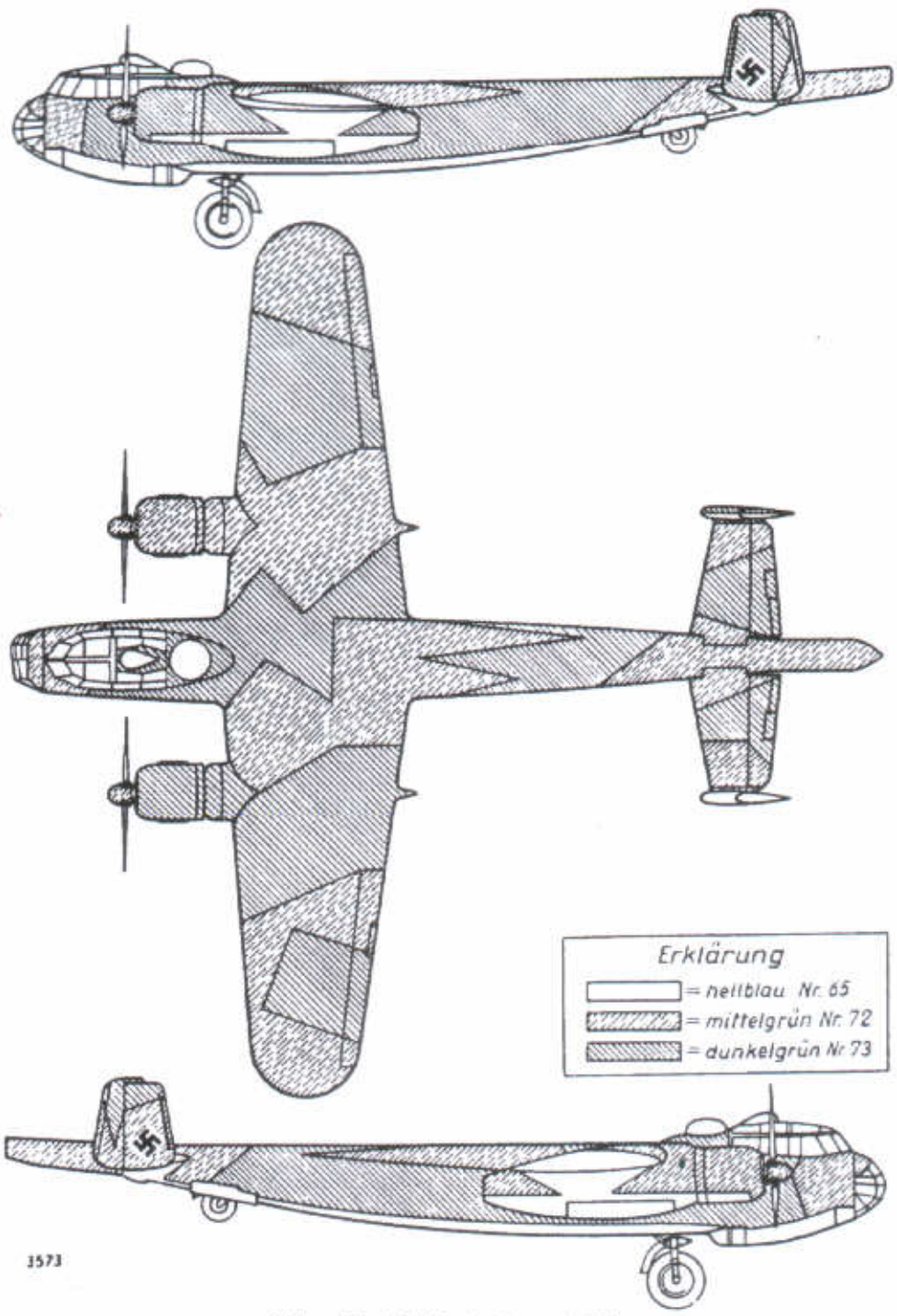


Abb. 11: Sichtschutzanstrich

INTRODUCTION

What you have before you is the latest instalment of my work on this subject. From *The Gordian Knot* of 1994, through *Colours of the Luftwaffe 1935-1945*, published in March 1997, to the present treatise on surface treatments and paints of the German Aviation Industry and Luftwaffe 1935-1945.

This has developed from its original purpose as an aid to the modelmaker, as represented by *The Gordian Knot*, which already went beyond an aid for the modeller through its strong reliance on contemporary documents, to the fourth continuation now in your hands. This is based exclusively on original documents. The fact that I have been able to refer back to them is due simply and solely to the altogether very positive response I received to my earlier works. This opened access for me to hitherto unknown material. The situation more or less begged for a new edition, as I did not wish to deprive those interested in this cornucopia of unknown information.

The new material has enabled me to check my previous statements and assumptions. I was able to investigate the link between the RLM colours and the RAL register to such an extent that I have devoted a whole chapter to it. My theories on the late war shades 81, 82 and 83 have also been confirmed insofar as the pigments of the RLM camouflage colours (building and ground camouflage) are identical with those used for the RLM aviation lacquers. The new material provided much new information and, quite especially important, indications as to dates when vital decisions entered into effect.

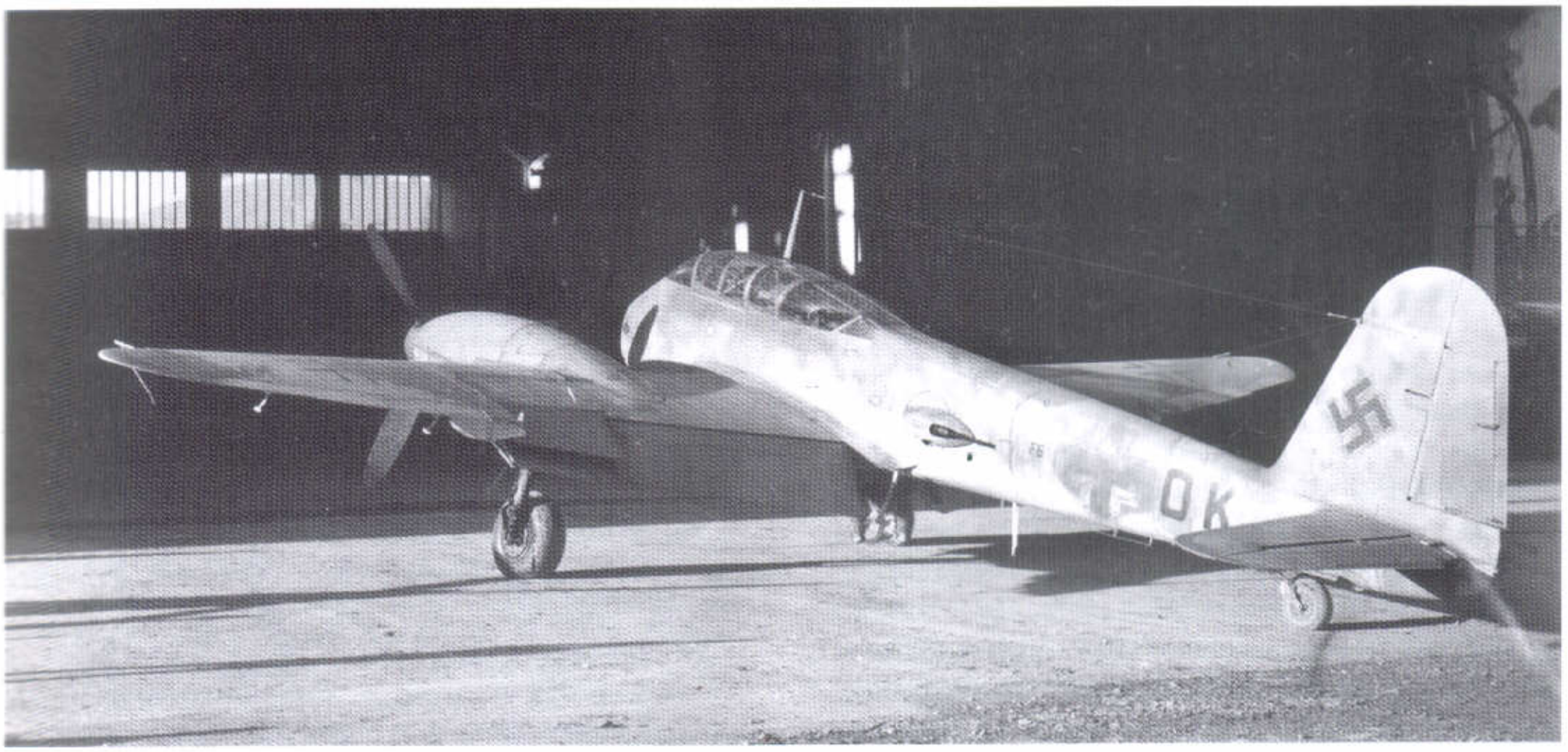
A great deal of space is devoted to information gleaned from other documents at my disposal. These have been quoted in the text whenever necessary. The documents came from various sources, correspondence from the RLM, the aviation industry and the paints industry. They provide a fascinating insight into the then world of the Luftwaffe and aircraft industry and the close links between and the influence exercised by the State and military organisations on the economy. The gradual realignment of the economy on wartime conditions is already clearly noticeable in the pre-war period in the light of contemporary documents. I feel I can therefore justifiably refer to the historical background to my work since most of the sources and links are not generally known.

I should also like to mention that I have used the aviation materials numbers in the text, such as, for example, aviation lacquer cleaning agent 7238.00, without further cross-references. Since these aviation materials are listed in the L.Dvs incorporated into it, I must ask the reader to refer to the pages on which the particular material is explained. In addition, I have used some of my source material in several sections because of its importance. I hope that this process will not be misunderstood as padding; imagine if I had simply referred to the relevant part of the texts within the subject-matter and required the reader to refer back to it. I am sure that the reader would have been more irritated by having the flow of his reading interrupted than by having to read once again a known section of text, but in conjunction with a different topic.

I always welcome useful criticism. Should anyone not agree with my comments or if they have material that takes this exercise further, I would ask them to write to me via the publisher. Because I consider it an honour and a pleasure to correspond with others in connection with my study, I have so far answered every letter received.

Michael Ullmann
Friedrichshafen
Germany

*3 **Below:** Messerschmitt Me 410A-3, F6+OK, WNr 10259, of 2.(F)/122 seen shortly after it was captured in Sicily in November 1943. It is finished in the standard camouflage of RLM 74/75/76 with the national markings on fuselage and tail toned down. Note the narrow black outline-only style crosses on the wings*



PRINCIPLES

What is colour?

For a better understanding of this treatise, certain principles must be understood on matters which are not general knowledge.

What is colour?

As this book is mainly concerned with 'colour', there is every reason for this concept to be clarified:

Colour is a sensory impression imparted by the eye (Deutsche Industrie Norm 5033 — German Industrial Standard 5033). It is characterised by:

- Shade: (formerly 'hue') describes the nature of colourfulness (e.g. red or green)
- Saturation: degree of colourfulness of a colour compared with a non-colour of equal intensity (grey)
- Brightness: strength of light sensitivity (link with any experiencing of colour)

Lacquer = Paint

Historically, lacquer has been known as a protective coating since about 1300 BC. The term is attributable to the Hindi word 'Lakh' from 'laksha = 100,000', probably a reference to the large number of lac flakes required to make the material. Shellac is the sole natural resin of animal origin of commercial importance. It is a secretion by the Asian lac insect, *Laccifer lacca*, which lives in trees.

Lacquer consists of:

Binder:

The non-volatile proportion of a paint without pigment. These can be:

- A refined natural product
- Cellulose nitrate
- Colophonium and oil
- Fully synthetically produced resins (artificial resins):

  alchid resin
  polyurethane resin
  epoxy resin
  polyester resin

Solvents:

Liquids in which the binder is dissolved. They evaporate almost completely as the lacquer dries and can be:

- Alcohols
- Esters

4 Above: *The wreck of an Heinkel He 111H-20, 5J+ES, formerly of 8./KG 4, abandoned at Berlin-Gatow in 1945. Red 'E' had standard camouflage in 70/71/65, the top surface being overlaid with large blotches of the late war RLM 76 that had a nearly bluish-white appearance. The aircraft had a yellow fuselage band, while the letter 'E' is red with a white border. Interestingly, the swastika is so washed out as to be nearly invisible*

- Ketones
- Aromatics
- Water

Colours (not in clear lacquer), which can be:
- Soluble colouring substances
- Pigments: colouring substances not soluble in solvents and binders
- Fillers: Generally colourless insoluble substances for 'stretching' the pigment

Paint additives:
- Anti-sedimentation agents
- Accelerators
- De-foamers
- Driers
- Softeners

Drying

The hardening of liquid lacquers into stable surface layers is called 'hardening'. It can be induced either through:
- air drying (physical drying, oxidative curing and air humidity hardening)

  or by
- polymerisation reactions

Paint management by the RLM

This section provides a summary impression of what the RLM/Luftwaffe understood by paint management and what value was attached to it. Individual concepts and processes are also explained in a way understandable to the layman. It has in fact been taken complete from a contemporary document, unfortunately only parts of which were obtainable. The date and title of the document are unknown but it must have been issued within the 1937-1939 period. It contains passages of text which are very similar to those in L.Dv 521/1, 1938 edition. No comparable text appears in the subsequent 1941 edition. The original was also produced in gothic font, which would indicate that the document was produced before 1942, since after 1942 all documents were published in normal sans serif script.

Paint on aircraft parts can be divided into three types according to the task it has to fulfil:

- protection against corrosion
- camouflage
- doping

Aircraft with corrosion-sensitive surfaces are sprayed once only (single-coat paint). Several coats have to be applied to aircraft whose surfaces have initially to be treated (taut fabric). The sequence of the individual coatings is called a 'lacquer group'. The lacquer group is named after the composition of the lacquers. The trade names by which the lacquers were originally called are now replaced by numbers. The following is an example of lacquers used to paint aircraft fabric:

Aviation lacquer group 20 consists of the following lacquers:
Herboloit combination primer grey-green BC 6965, new designation 7113
Herboloit combination intermediate layer silver BC 6966, new designation 7114.01
Herboloit top coat silver matt-grey 550 BC 6954.

These lacquers are thinned with Herboloit special thinner BC 6970, new designation thinner 7213.00, when they are applied.
The lacquers used for the individual components are indicated in the aircraft log. Since solvent lacquers cannot be applied on top of others, care has to be taken when improving the coatings that only lacquers indicated in the log are used.
Aircraft parts that are riveted or screwed together must be treated individually before assembly. If this is not done, they corrode. Aircraft paints are subject to weathering. Strong sunlight renders the light oils in the lacquer and corrosion protection volatile. Only the harder components are left. They feel brittle and wrinkled to the touch.
Careless handling can similarly cause damage to the paintwork. Petrol, benzol mixture, P3 solutions and lubricants attack paints and dissolve them. On the other hand, proper cleaning and care will greatly reduce or slow down the decomposition of the paint. The surface is also protected against humidity by the water repellent properties of cleaning agents before application.
Some of these agents are simple preservatives that may be applied only after the paintwork has first been cleaned while others are both cleaning and care agents. Paint management proceeds as follows:

1. Dusting the paintwork with a soft brush.
2. Cleaning highly soiled, oily patches with aviation lacquer cleaning agent Z.
3. Applying and rubbing down the lacquer preservative with a clean rag according to the instructions for using the agent. It is important in this case that preservatives are applied thinly and well rubbed down so that no dust can adhere to the treated surface.

A screwdriver must always be available during such work on the supporting surfaces, fuselage and control surfaces for tightening any loose screws on fairings and the like.
Damage caused to the paintwork should be made good as soon as possible. It is important in this case to ascertain whether the damage to the preservative was caused by wear and tear, i.e. walking on the surface, impact and the like or by movement of the plating in the joints or simply the shearing off of rivets. Simple wear and tear can be immediately made good. If the paint peels off following work on the plating, the testing unit must first be advised, who will then give further instructions.

With metal aircraft, remaining patches of colour must be removed with aviation stripper 7210.00 during touching up. Thinner must be applied extremely sparingly so it does not run and enter the interior of the aircraft through flaps or openings. The area should be washed down with aviation cleaning agent Z following stripping. Make sure that the stripper is removed with particular care from under the rivets and plating joints. The new lacquer group must then be applied again as indicated in the log for the aircraft concerned.

With aircraft of composite construction, plate residues must first be removed with thinner 7210.00. The edges of patches from which the paint has been removed must be ground down to achieve a uniform coating. The dust which is created in the process must be removed with a soft brush. The new lacquer group will be indicated in the log. Proceeding the same way if the paintwork or fabric is damaged.

With major damage, e.g. if the fabric is penetrated, the tear must first be sewn up even if it is only small in size. The paint in the area of the damaged part must then be soaked off with aviation thinner 7230.00. The thinner must be applied with a soft rag. A piece of fabric large enough to cover the tear must first be cut to the necessary size and is then stuck to the tear after soaking in aviation lacquer 7130. After drying, the area is again painted with aviation lacquer 7130. The lacquer group for the aircraft pattern can then be applied after the appropriate time for drying.

Padding strips stuck to the fabric at the ribs or at the transitions between the fabric and metal or wood must be fastened back as follows should they peel off:

1. Strips stuck down to the fabric:
   soak the appropriate patch with aviation thinner 7230.00 and then proceed as above;
2. Strips stuck to metal:
   Coat the metal with Glasso adhesive S 13499.
   Stick down the padding strip and press hard.
   Remove excess adhesive from the metal with air craft cleaning agent Z. Treat the metal and padding strip in accordance with the lacquer group in the log."

Underlying facts

To arrive at a general understanding of the problems of Luftwaffe colours and to put them to a logical assessment with a view to working up the material for this book, the underlying facts obtained during research for this chapter are listed below. Analysis—and assessment—especially when using contemporary images requires a special knowledge, the broad lines of which are set out in this chapter.

- Colour photos, especially those in the early period of colour photography (the '30s and '40s of the past century) are not reliable documents. They were not immediately when taken and much less so 40 to 50 years on. Every hobby photographer knows the effect when he takes scenes with the same camera and under the same lighting conditions but with films from different manufacturers. The differences are surprising. Sometimes, the film has a green tone, at other times it is bluish. Conclusion: a colour photo is not a document of particular relevance for our purposes and can serve only as a guide.

- Nor are original remains of colour on aircraft parts reliable evidence. The colour changes through oxidation with the air and through oxidation, grease or fuel. The nesting of debris in the earth similarly alters the colour. Colour fades through the effects of ultraviolet light.

- Because of the different ingredients, binders and production methods compared with present-day colour manufacturers, the colour reproduction of an established shade did not have the quality we know today or expect on the basis of the standards. This means that, at the time,

***5:** A Focke-Wulf Fw 44 in an overall silver finish with an antiglare paint (possibly dark green) on the top of the fuselage. The aircraft has a civil registration applied as the official instructions (see page 146) and is probably in service with the Deutsche Luftsports Verband (DLV) in the mid-1930s*

colour could differ slightly from one batch to another, especially if the paint was produced by different manufacturers. The L.Dv 521/1 of November 1941 that I have used in fact supports this statement. It says:

> "They are made by a number of leading paint firms under licence according to the recipes of an original producer."
>
> It also says regarding the painting of pipes:
>
> " ... minor differences in the shade are acceptable as against the RLM colour card when painting pipes."

• People's memory of colour is unreliable and everyone experiences colour differently.

A person's recall of a colour is useless. If you do not believe that, try a simple test. Enter a room where you can create the same lighting conditions (e.g. a darkened room with electric light) and look at an unfamiliar, coloured object. Now remove the object and, a day later, try to identify the shade of the object from a colour chart from memory. You will be surprised at the result. You can check the effects of different lighting conditions on the appearance of a colour in the same way. The outcome will also come as a shock.

• The RLM aviation lacquers are described down to the fine detail in the various editions of the L.Dv. 521/1. Where the lacquer requires these laborious application processes, these were essential if the paint was to be applied according to the rules.

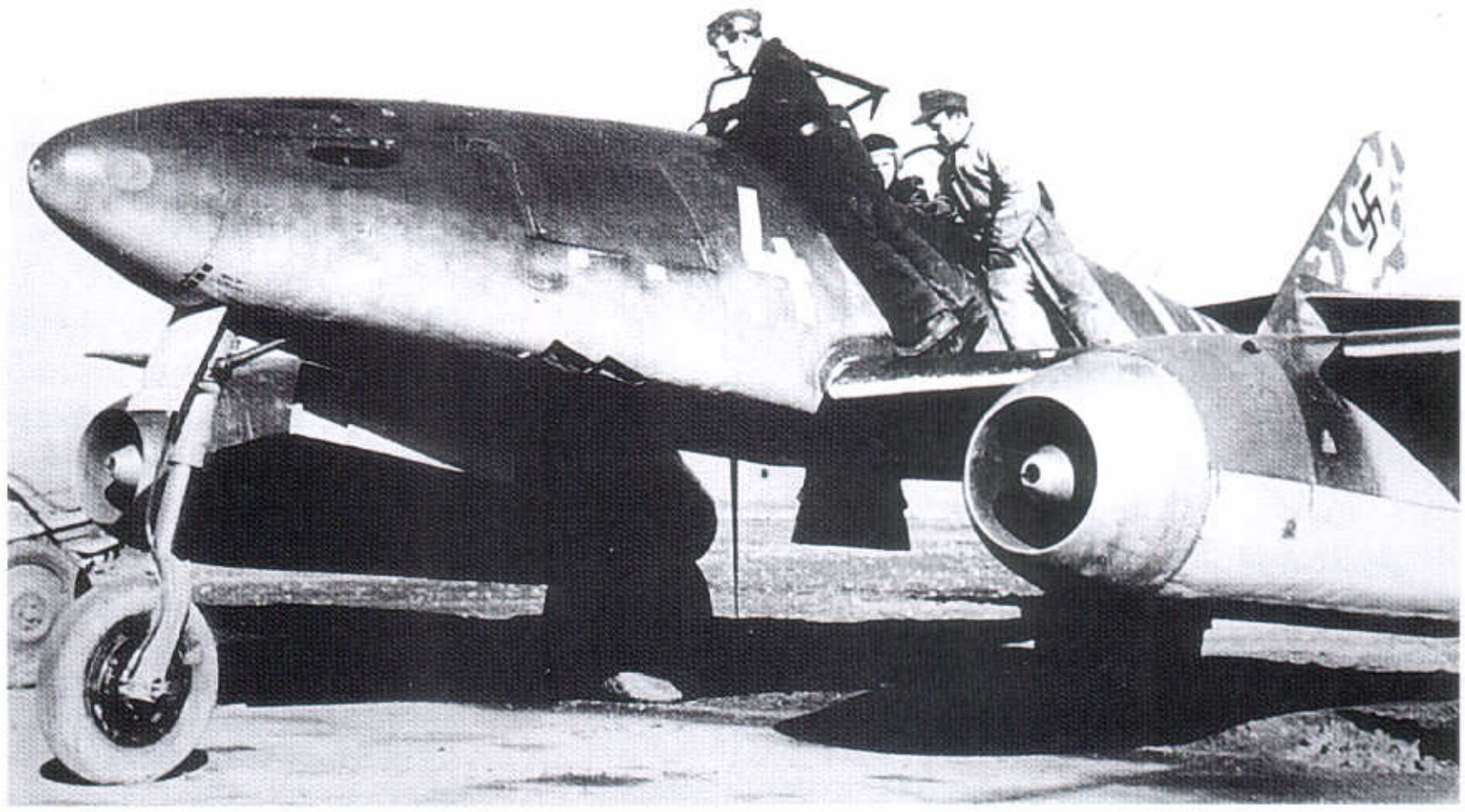
However, there was a war on. Quite understandably, there was simply no time or technical equipment to process the lacquer according to the rules. Such every day points as the regulation thinning might well be simply overlooked. One may well ask, how did the paint behave if not applied according to the rules? Was it darker or lighter? Did the shade change? Was keeping quality affected? How did RLM 65 alter when the Clearcote JS 238 was applied? How was the colour affected by cleaning and sealing (see the 1938 edition of L.Dv. 521/1)? An abundance of open questions, the answers to many of which already seem obvious. These are only some of the facts which are bound—with a probability edging on certainty—to have resulted in the colours looking different when applied other than according to the L.Dv. 521/1 charts.

• Different application methods (spraying, brushing, etc.) also undoubtedly had their effect on the appearance of the colours used.

We now know that old colour photos and colour remnants are unreliable as evidence, that shades varied from one manufacturer to another, and that people have a poor colour memory. How, you may ask, can we be so sure?

There is no shortage of reasons! We now know that a scientifically precise determination of the shades originally used can no longer be obtained today. The best we can do is to approximate the colour as closely to the original as possible.

In the opinion of this author, in the light of the above facts, a scientifically precise reproduction of the colour shades is out of the question today.



***6:** The paintwork on the vertical tail surface of this Me 262A, 'White 4' of Kommando Nowotny, seems to indicate that templates were used to apply the patches of dark colour as a number of early Me 262 deliveries to the unit wore this pattern on their tails. The overall paint work on the upper surface of the fuselage and sides appears to be in a single colour, which because of its dark appearance is probably RLM 81 or 83 but may be 70 or even 71. The nearer of the jet engines shows repairs, the air intake being in bare metal, while the cowling behind it is probably painted with RLM Grau 02*

HISTORICAL BACKGROUND

Regulations and official documents

A brief excursion into history will perhaps provide a better basis of comprehension for this work.

The RAL

The *Reichsausschuss für Lieferbedingungen* (RAL) or Reich Committee for Conditions of Supply, was formed in 1925 in the aftermath of the Versailles Treaty. In 1927 it was decided to recommend a restricted number of colours for general use. This was done for simplification and economy of purchasing and storage and thereby to streamline production against the background of the ongoing economic crisis that had affected Germany since the end of the First World War. Particular importance was attached to colours being mixed with local pigments. This was done to save valuable currency which would otherwise be needed to purchase raw materials abroad, since the Reichsmark was valueless abroad.

40 colour shades were laid down, including 13 basic colours and 27 obtained by mixing these 13. The number of colours increased sharply during the 1930s as new authorities and organisations of the Third Reich were added (e.g. the Railways, Posts, Labour Service, Army, etc.). By the end of the 'thirties, the RAL Register covered more than 100 shades.

This led to a rethink in 1939 to 1940. All colours were allocated to the main groups 1 to 9 and were given numbers within these groups. As from then, the colour collection was called RAL 840R (R = revised). This colour collection remained in force to the end of the Second World War.

The colour collection was re-examined in 1953 during the period of reconstruction. In consultation with the few remaining users and with their agreement the colours no longer required were scrapped. These were especially colours used for military purposes and by party organisations of the Third Reich, the Railways and the Posts, i.e. colours which are now of particular interest to restorers and modellers. A further review took place in 1961. Since then, HR stands for *Hauptregister—Revidiert* (Principal Register—Revised). Official colour names were introduced in 1962 so that colour patterns were protected from clerical errors. The names used before 1962 ceased to apply.

The German Aviation Paints Industry

A number of companies had surface treatments for light metals in their product ranges in the early Thirties. Since light metal was the main material for aircraft, surface protection was needed especially for metals prone

7 Above: *An immaculate Heinkel He 60, D-IVKA, tied up to the slipway at Bug am Rugen on the Baltic coast in July 1936. The aircraft is a perfect example of the finishing requirements for Luftwaffe aircraft of the time: an overall coat of RLM Grau 02 (probably 7105.02) with the underwater portion of the floats in silver. The upperwing top surface may be yellow but cannot be seen clearly*

to corrosion, such as magnesium or electron. Examples of products used by the aviation industry were:

Avionorm	Lüdicke & Co.
DKH L**	Dr. Kurt Herberts
Ikarol	Warnecke & Böhm AG
Tokiol	Zoellner-Werke AG

The names of these products and companies appear in Lufthansa and Luftwaffe (RLM) documents. This shows that the Luftwaffe (i.e. the military) were using the same surface treatments for its aircraft as civilian users, which was due to the fact that these treatments at that time represented the state of the art. As the 1938 edition of L.Dv 521/1 shows, most of the paints that were then given an aviation material number (aviation material with full official backing) were Ikarol products from Warnecke & Böhm.

The introductory words from an information brochure from Warnecke & Böhm on Ikarol protective coatings are quoted below:

"**Light metals and the problem with their protective paintwork.**
With the increased use of magnesium and its alloys, the search for suitable protective paints for these metals has recently become acute. It has been found in practice that magnesium and its alloys, like the more important aluminium alloys, require special paints. Experience obtained with protective coatings for iron and steel proved to be impracticable on light metal alloys. On the contrary, the fact was that paints which had proved to provide excellent protection for iron and steel were quite unserviceable for light metals.
This sometimes radically different behaviour of light metals towards paints compared with steel and iron was apparently due simply, on the one hand, to the physical properties of the light metals and, on the other, to their chemical properties. Entirely new, special paints had therefore to be composed for light metals which had to be just as good as those available to date for steel and iron with regard to their useful and life and protective qualities. There was a second requirement: these new protective paints for light metals had if at all possible to be produced from purely German raw materials (*Author note: compare with the historical data on RAL earlier in this chapter*).
Convinced of the particular importance that would be attached to the area of 'protective paints for light metals' in the near future, we had already commissioned scientific laboratories years ago to find a solution to this problem, i.e. to devote their full efforts to 'fault-free protective paints for light metals from German raw materials as far as possibl'. And it is not going too far to say that after lengthy, tireless research work, undertaken by resort to the latest test methods and in close cooperation with the light metal producing and processing industries, we succeeded in fulfilling this task.

The light metal processing industry now has sea water resistant and high temperature resistant IKAROL lacquers at its disposal which have proved their worth in every respect even under the poorest and most taxing conditions and which cannot be equalled in protective value and useful life. We shall be pleased to provide certificates and reports and to quote references from the authorities and from industrial establishments for this purpose at any time. In this connection it is worth examining the testimonials from some of our leading aircraft factories at the end of this paper. As we know, demands are made especially on protective paints for light metal aircraft which exceed the usual limits in every respect.
Because of our extensive experience over the years with light metal protective paints, we can now give every firm practical, expert advice in this connection. We would therefore invite you to see for yourself the value of our IKAROL paints as a protective coating for your finished products of magnesium or any other light metal."

The extremely self-assured wording of Warnecke & Böhm's information leaflet clearly shows that with the IKAROL lacquers they had the most advanced product of their time for protective coatings for light metals and had no doubts as to the superiority of their product.

The L.Dv 521/1 of 1938 shows in its listing of lacquer groups and aviation paints how many IKAROL products the RLM had taken up. The superiority of IKAROL products was such that in the course of time they dislodged all other makes from the market. This is evident from L.Dv. 521/1 of November 1941:

"They are produced under licence by a number of leading paint firms according to an original manufacturer's recipes."

This 'original manufacturer' was Warnecke & Böhm. A listing of Warnecke & Böhm's licensees in 1942 includes a number of former competitors who had similarly made their own products for surface protection of light metals:

Company	Comments
Glasurit	
Herberts	Manufacturer of DKH paints
Herbig-Haarhaus	Manufacturer of Herboloid paints
Lüdicke	Manufacturer of Avionorm paints
Ruth	
Tebes	
Thurm & B.	
Wagner	
Zoellner	Manufacturer of Tokiol paints
Eluf	Ebersfelder Lack & Farben Fabrik
Klinkert	A subsidiary of Warnecke & Böhm in Zwolle, in the Netherlands

This listing clearly shows Warnecke & Böhm's posi-

A selection of press advertisements from the 1930s and '40s for German paint manufacturers. The aircraft featured in the advertisements probably represent the individual paint manufacturer's most important aero-industry client

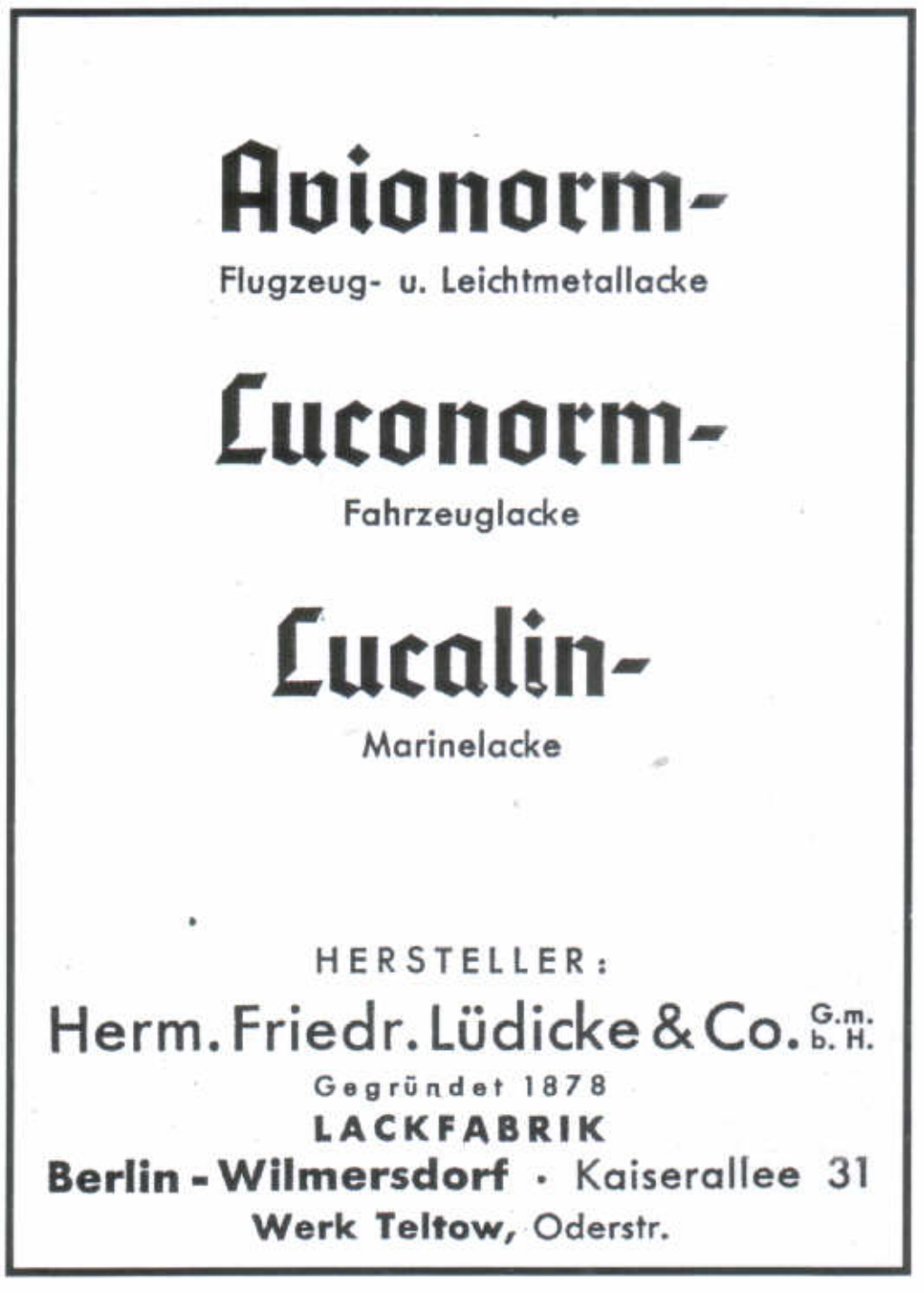
8 Right: *'Ikarol' from Warnecke & Böhm of Berlin, the premier paint manufacturer of the period*

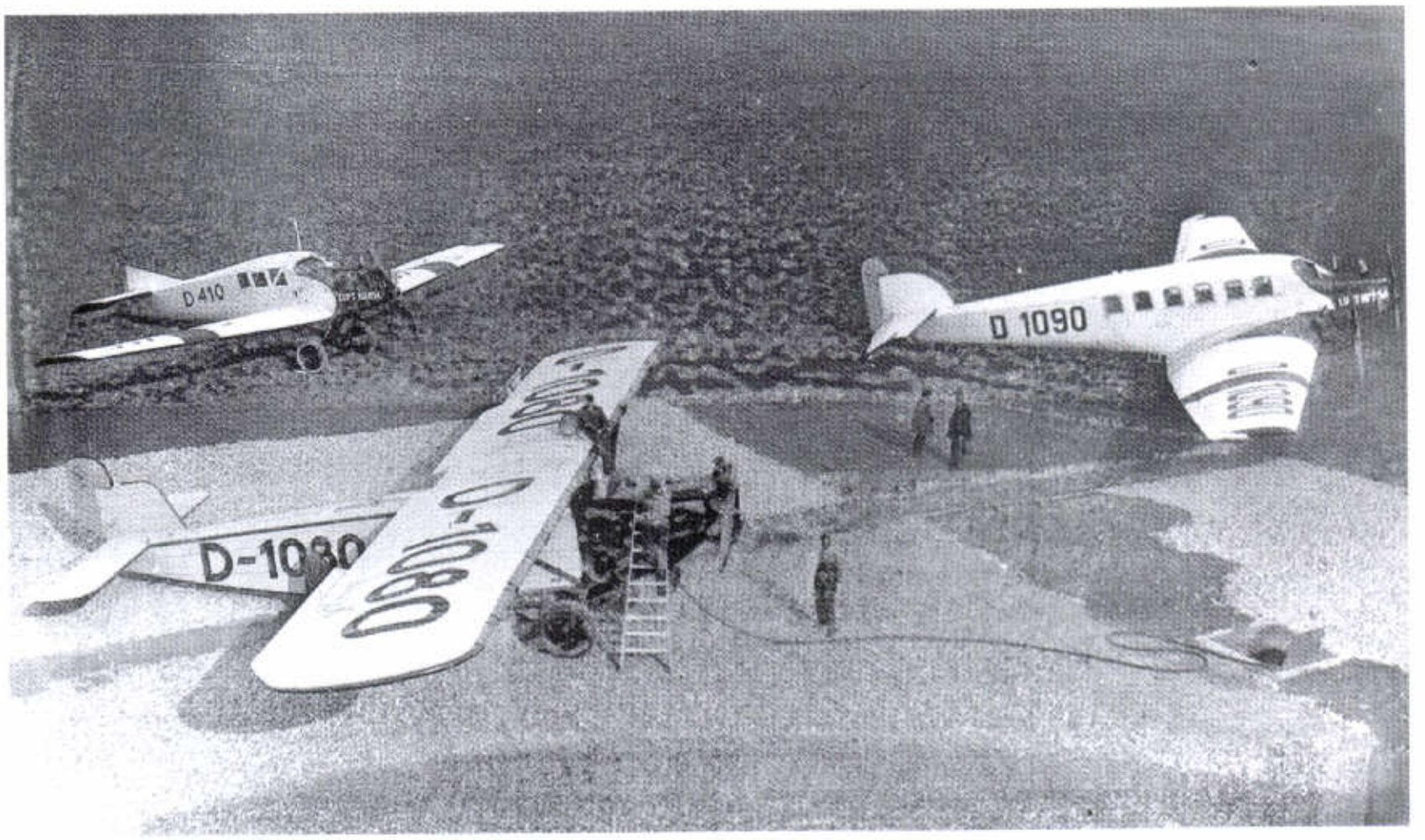
9 Below right: *'DKH' paints by Dr Kurt Herberts, Wuppertal*

10 Bottom right: *'Avionorm', from Lüdicke & Co of Berlin-Wilmersdorf*

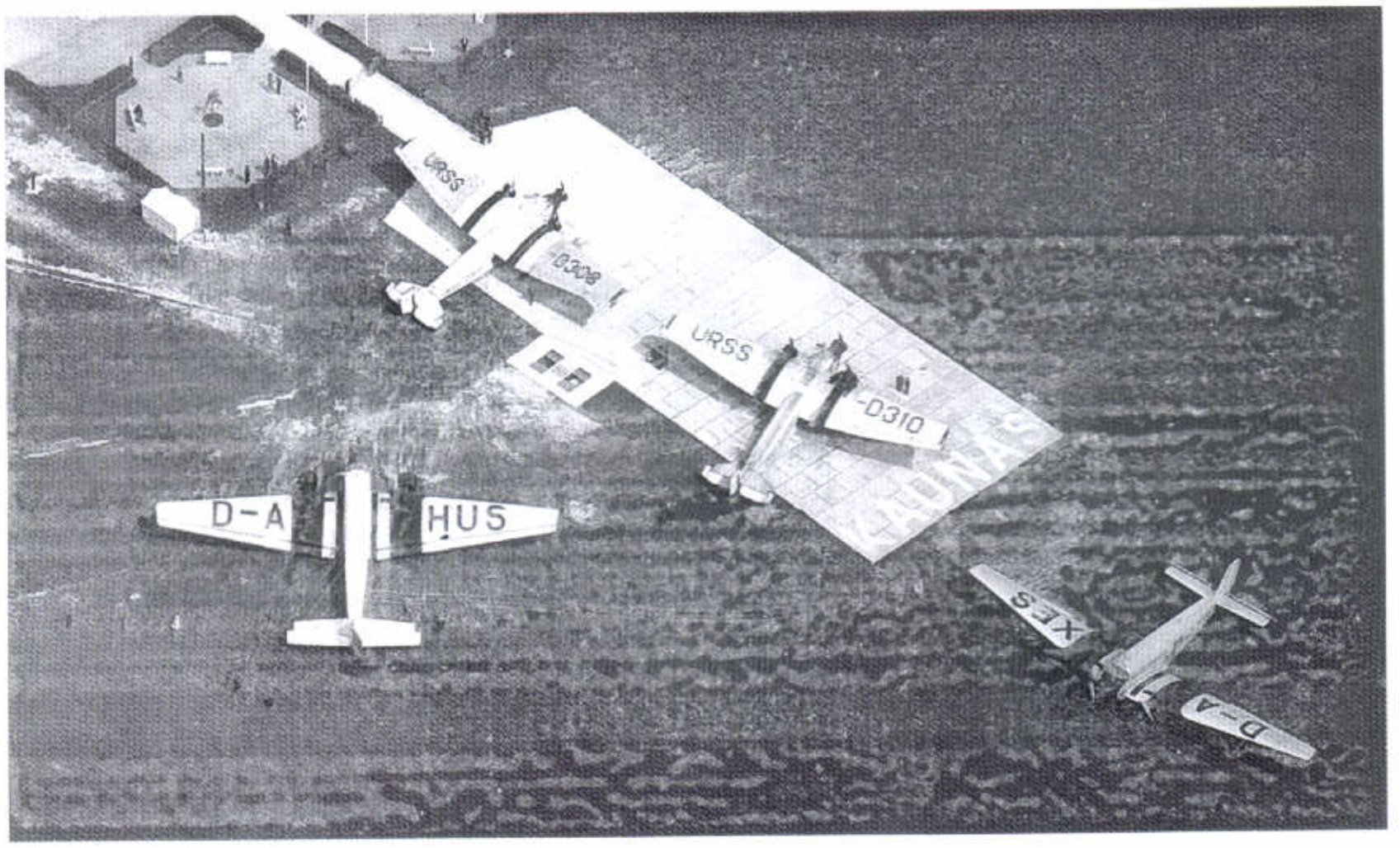
11 Below: *'Zoellner-Lacke' from Zoellner, also based in Berlin*

DKH FLUGZEUGLACKE
für Metallkonservierung außen und innen; Leinen- und Baumwoll-Imprägnierung; Sperrholzlackierung außen und innen; Kennzeichnungslacke nach Din L 5; Hoheitsabz. auf Nitro- und Ölbasis
Dr. Kurt Herberts & Co.
vormals O. L. Herberts. Gegründet 1866
Lackfabrik, Wuppertal-Barmen

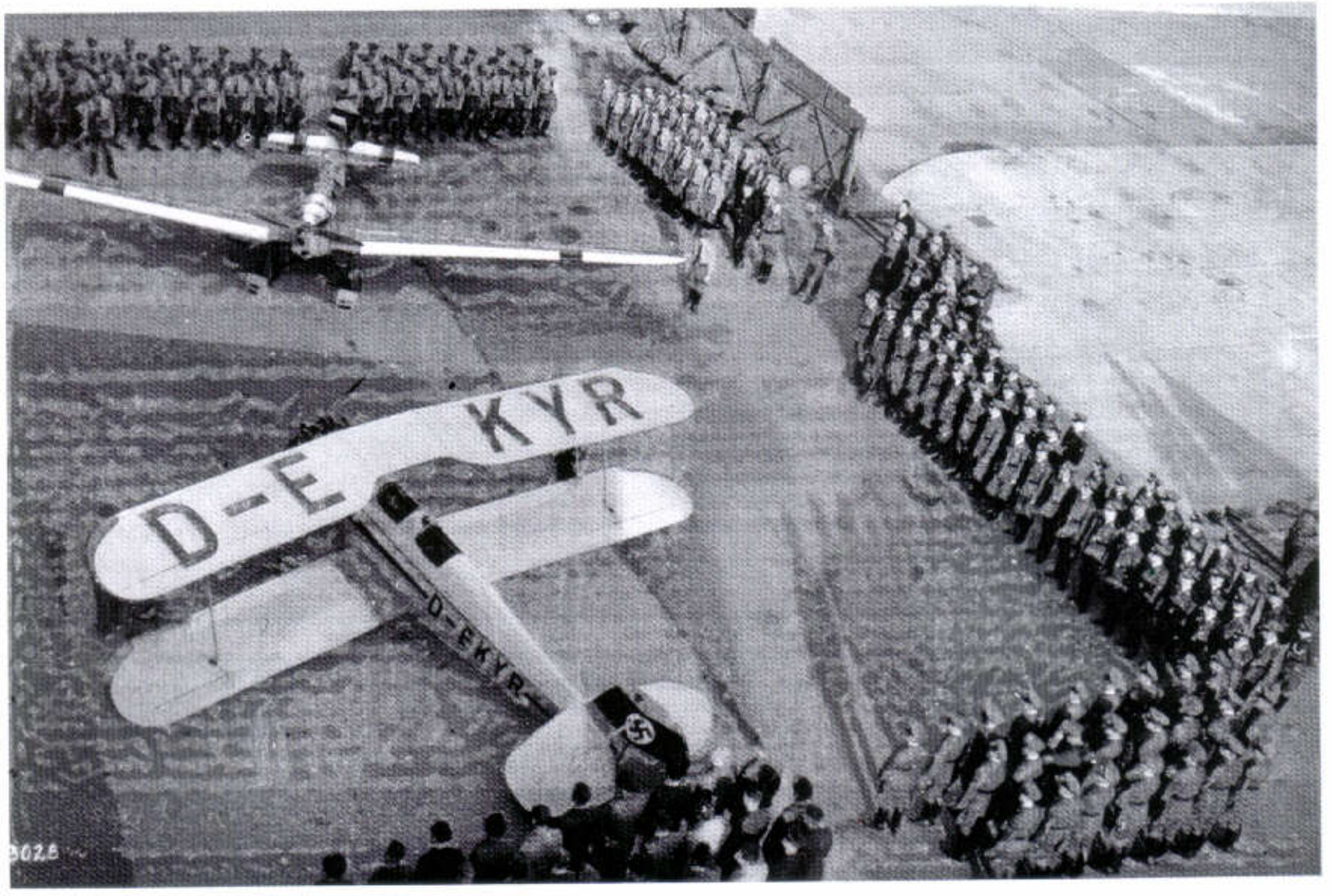




12: *Seen in front of the terminal building at Prague-Ruzyne, are three German civil aircraft in typical markings and finish of the 1930s. The date must be sometime before November 1932 when the Lufthansa Junkers F-13, D-410, was written off. The Junkers G 24, D-1090, also belongs to Lufthansa, while the Dornier B Merkur is in service with Deruluft. All three appear to be finished in silver with glossy black engine cowlings. The letter-number registrations were used until 1934 when all-letter registrations came into use* *(see page 146)*



13: *From April 1934 German civil aircraft used all-letter registrations, later confirmed in 1936* *(see page 145)*. *These identified both the aircraft and its weight class. Sitting on the pan at Kaunas, Lithuania, in the mid-'30s are two Lufthansa Junkers 52/3ms, D-AHUS and D-AXES, accompanied by a pair of Soviet Deruluft ANT-9s. All four aircraft appear to be in silver finish with black engine cowlings and wing stripes to hide oil and exhaust stains. Note that the Ju 52s do not yet sport swastikas on the fin, contrary to requirements* *(see page 146)*



14: *From 1933 the Nazi Party began to assert control over all flying in Germany by bringing flying clubs under the control of the paramilitary DLV, both to handle the expansion of clandestine military flying and to promote airmindedness. Here an immaculate Heinkel He 72, D-EKYR, and a Klemm 25 are the focus of the attention of a DLV unit. The He 72 appears to be finished in overall L40/52 Hellgrau, while the Klemm carries a more complex 'civilian' finish. The date must be sometime between April 1934 when the letter codes were introduced and mid-1935 when the DLV became the Luftwaffe*

Inserts have been added to the copy of L.Dv 521/1, 1938 Edition at the author's disposal. 'Inserts' were the regular amendments to the Regulations. These inserts therefore kept the Regulations up to date at all times.

So far, the author has been unable to confirm the suspicion that inserts were also issued for the November 1941 edition. However, amendments other than inserts have been found. In Luftwaffe *Verordnungsblatt 16, 1943*, dating from 5 April 1943, the foreword indicates the following alterations were to be made by hand:

"As of 1.5.1943 RLM colour designation suffix '-' for aircraft paints will be amended to RLM shade '99'.

Example: Formerly aircraft paint 7102.-, now aircraft paint 7102.99.

Both quality and production method of the affected aircraft paints remain unchanged.
In the case of the two L.Dvs named above, where aircraft paints with 4-digit numbers are followed by '-', the latter is to be replaced by a hand-written '99'.
The note on page 7 of L.Dv 521/1 part 1 is to be amended by hand with these words: '*) The number 99 after the point of the 4-digit paint number means: Precise shade is unimportant.'
The above amendment will be taken into consideration on future OS-lists, which accompany the aircraft industry's records of the aircraft."

The amendment instructions quoted above relate only to L.Dv 521/1 and L.Dv 521/3. L.Dv 521/2 was not affected because the amendment had already been allowed for here. The issues of the L.Dv 521 series printed in this book give the unchanged wording. This amendment also makes it clear that '-' and '99' mean the same.

The *Sammelmitteilung* (Collective Communication) of 1.7.1944 contains changes to L.Dv 521/2 (Gliders). It was from just such changes that the author had hoped to get clarification of the later shades RLM 81, 82 and 83.

It is also possible, however, that because of the war situation, no inserts were produced for the November 1941 edition of L.Dv 521/1 and amendments (see note on L.Dv 521/2 above) were circulated instead through RLM publications. The following passage from General Announcement 2 of 15 August 1944 seems to indicate that these anticipated inserts never existed:

"Camouflage colour shades and their distribution over the aircraft have been re-established on a uniform basis. The firms responsible for issuing camouflage drawings will be given a camouflage atlas by E-Stelle Travemünde which sets out the requirements. With the issue of this camouflage atlas, the industry is prohibited in principle from using types of camouflage and colour shades other than those prescribed in this camouflage atlas, e.g. on special request from military units, without the express consent of E-Stelle Travemünde. As a result of this realignment, the following RLM shades will now no longer be used: 65, 70, 71 and 74. Shade 70 remains prescribed only for propellers".

So far as it has been possible to trace, the November 1941 edition of L.Dv 521/1 reached the Luftgau Command's Regulation Centres between 15 December 1941 and 3 January 1942 by general circulation No. 3141. It undoubtedly took several months before the new L.Dv 521/1 was circulated by them to all units. *Sammelmitteilung* 1 of July 1944 indicates that the RLM had announced the future introduction of camouflage colour shades 81/82 instead of 70/71 by a letter dated 21 August 1943.

The distribution of L.Dv 521/1, November 1941 edition, which was made in early or mid-1942 and the RLM's letter announcing the introduction of new colour shades are only 18 months or so apart. What is already evident when the 1941 L.Dv 521/1 was drawn up and distributed is that a camouflage atlas was in the pipeline. Is that why no inserts were produced? These questions will be cleared up only when a camouflage atlas of this kind is discovered, an event which, sadly, has not so far occurred.

15 Below: *The title page to L.Dv 302, the technical handbook to the Heinkel He 46, dating from July 1935*

Baubeschreibung

Nr.: 443

Datum: 1. 7. 1935.

He 46 D

Einmotoriges Land-Übungsflugzeug
mit Motor SAM 22 B

Aufklärungsstaffel 3/124
Kassel

Diese Baubeschreibung enthält:
3 Teilhefte.

Blatt 1

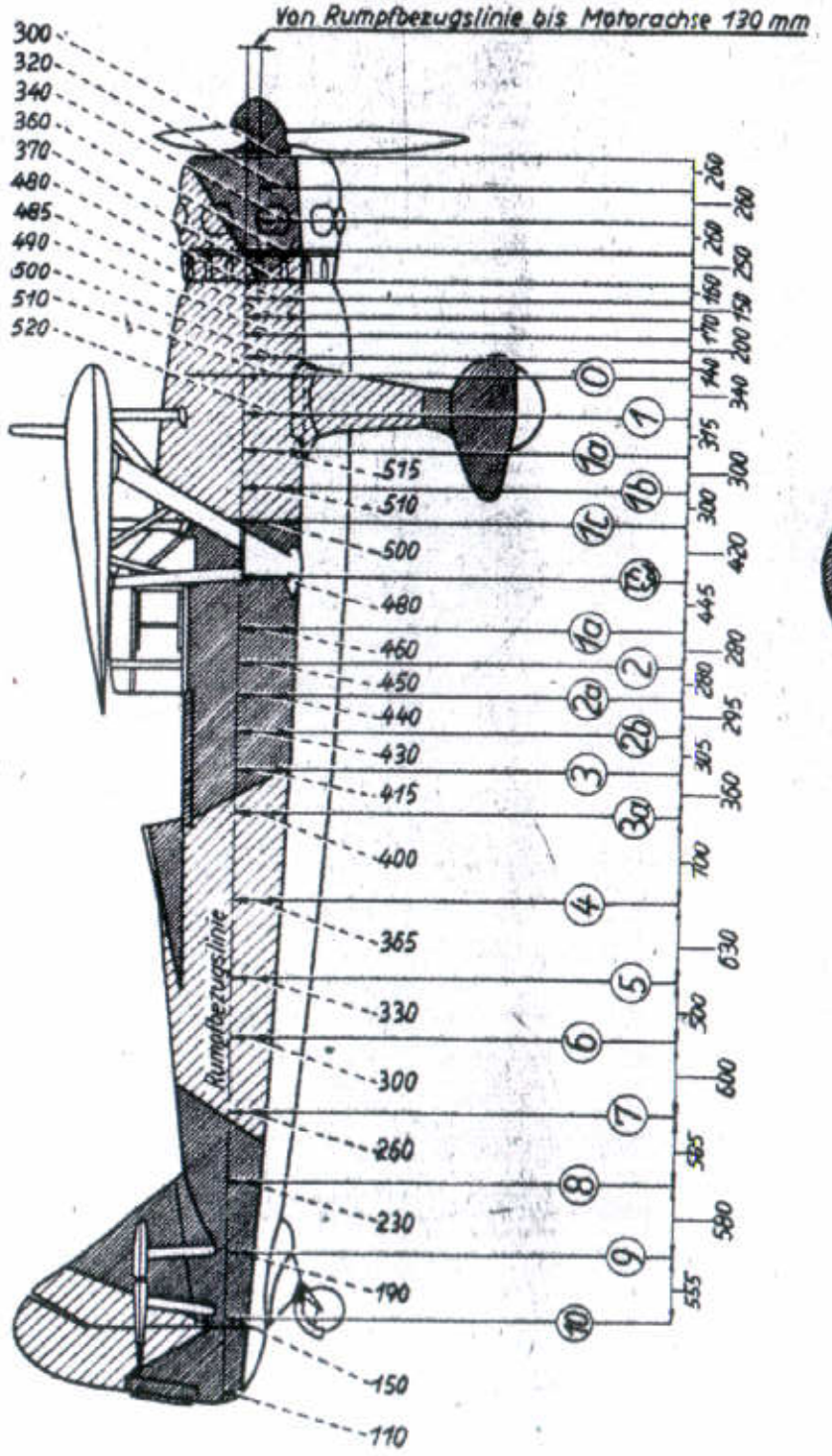
Dieses Anstrichblatt enthält 5 Blatt

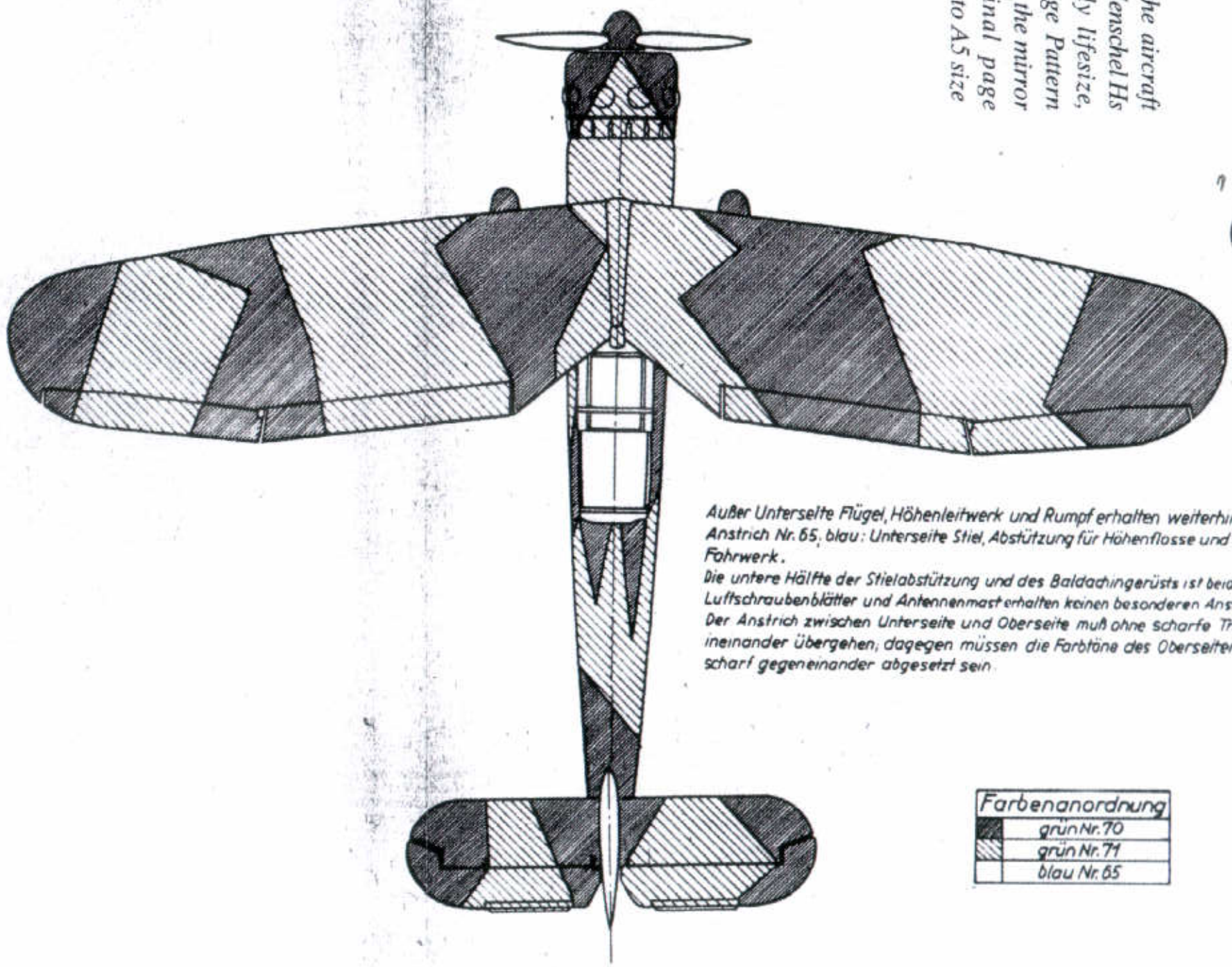
Farbanstrich für Flugzeuge He 46

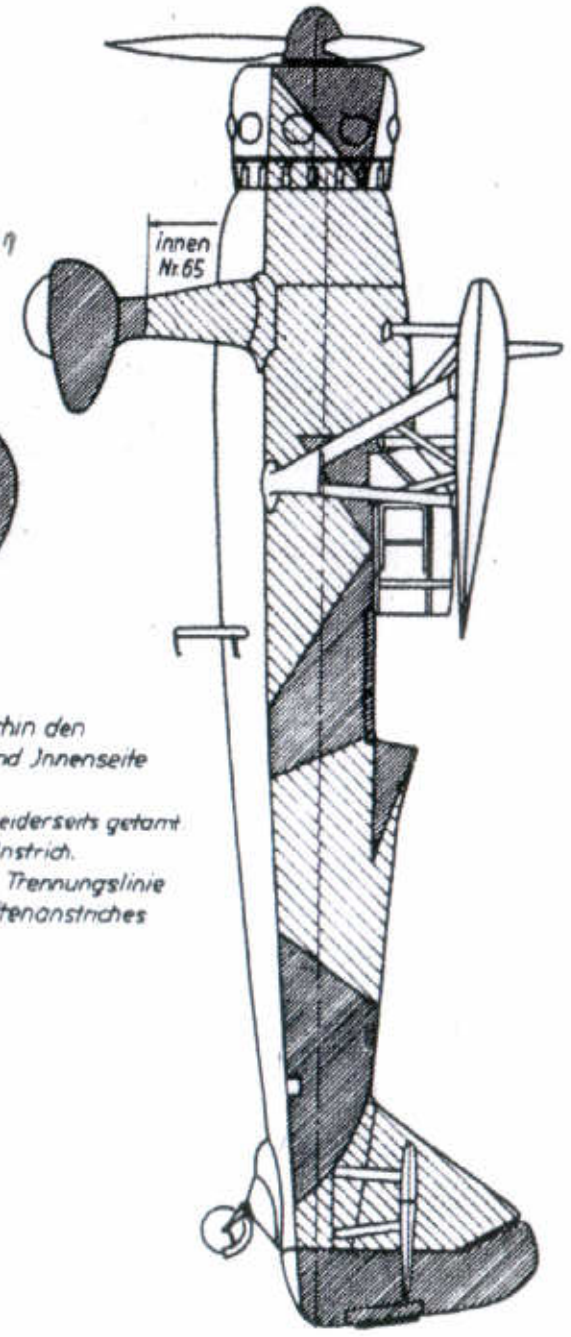
(Dichtungs- und Isolationsmaterial ist mit anzugeben)

Baustoff	Anstr.-zahl	Streichen Spritzen	Trocknen Ofen Std.	Trocknen Luft Std.	Musterbezeichnung des Anstrichmittels (Nur nach Angaben auf der Kanne)	Bemerkungen
2	3	4	5	6	7	8
					Avionorm-Nitro-Entfettung Nr.2362	Lüdicke & Co.
					" " Decklackverdünnung 1333	" "
					" Ölgrund-Verdünnung 2551	" "
						Anstr.u.Entwicklg.
Stahlrohr	1	spritzen	6		Avionorm-Ölgrund hellgrau 5759	Lüdicke & Co.
Aluminium	1	spritzen	4		Gemisch 1:1 aus Avio.Nitr.Deckl.ellb.1708	" "
					" " Lasurl. " V192	" "
Leinenband	1	streichen			Gem.aus 50% Paraffin,30% Stearin,20% Benzen.	
soweit aus Elektron	1	spritzen	6		Avionorm-Ölgrund grau 5706	Lüdicke & Co.
	1	spritzen	4		Gem. 1:1 aus Avio.Nitr.Deckl.ellb.1708	" "
					" " Lasurlack " V192	" "
Aluminium	1	spritzen	6		Avionorm-Ölgrund hellgrau 5759	Lüdicke & Co.
	1	spritzen	4		" Nitro-Decklack silber 1708	" "
	1	spritzen	4		" Lasurlack " V192	" "
soweit aus Elektron	1	spritzen	6		Avionorm-Ölgrund grau 5706	Lüdicke & Co.
	1	spritzen	4		" Nitro-Decklack silber 1708	" "
	1	spritzen	4		" Lasurlack " V192	" "
Kiefer u.Sperrh.	2	spritzen	6 je		Bakelite-Firnis-R	Bakelite G.m.b.H.
Weber-Leinen 1403	1	streichen	5		Avionorm-Grundtränkung rot 5592 a	Lüdicke & Co.
FL II, o.Kleber-L. 11 FO IV oder	1	streichen	5		" Spannlack 5612	" "
Baumwollstoff wie Kleber 16 FH	1	streichen	5		" Grundtränkung rot 5592 a	" "
	1	spritzen	5		" Aluminium-Decklack 5788	" "
	1	spritzen	4		" Nitro-Decklack grau 7007	" "
	1	verteilen			Verteiler 5791	
	1	spritzen	4		Avionorm-Nitro-Decklack grau 7007	Lüdicke & Co.
	1	polieren			Paste 2596	
	1	spritzen	4		Avionorm-Nitro-Decklack hellblau 4995	Lüdicke & Co.
					Rumpfwerk	
Entfettung	1				Flugzeug-Teilbezeichnung	
Löser						
					Rohrgerüst	
					Rumpfhauben innen	
					Verkleidung	
					Rumpfhauben innen	
					Rumpfhauben aussen	
					Rumpfhauben aussen	
					Vorgebungsgerüst	
					Besponnung	
					Abdeckungen u.Strom-Linienstreifen	

16: *An extract from L.Dv 302, the Heinkel He 46 technical manual of 1935, which details the paints to be used for finishing and repair; the primary external finish being Avionorm Nitro-Decklack Silber 1708 with a finishing coat of Lasurlack V192, both supplied by Lüdicke*




Außer Unterseite Flügel, Höhenleitwerk und Rumpf erhalten weiterhin den Anstrich Nr. 65, blau: Unterseite Stiel, Abstützung für Höhenflosse und Innenseite Fahrwerk.
Die untere Hälfte der Stielabstützung und des Baldachingerüsts ist beiderseits getönt.
Luftschraubenblätter und Antennenmast erhalten keinen besonderen Anstrich.
Der Anstrich zwischen Unterseite und Oberseite muß ohne scharfe Trennungslinie ineinander übergehen; dagegen müssen die Farbtöne des Oberseitenanstriches scharf gegeneinander abgesetzt sein.
Farbenanordnung
grün Nr. 70
grün Nr. 71
blau Nr. 65

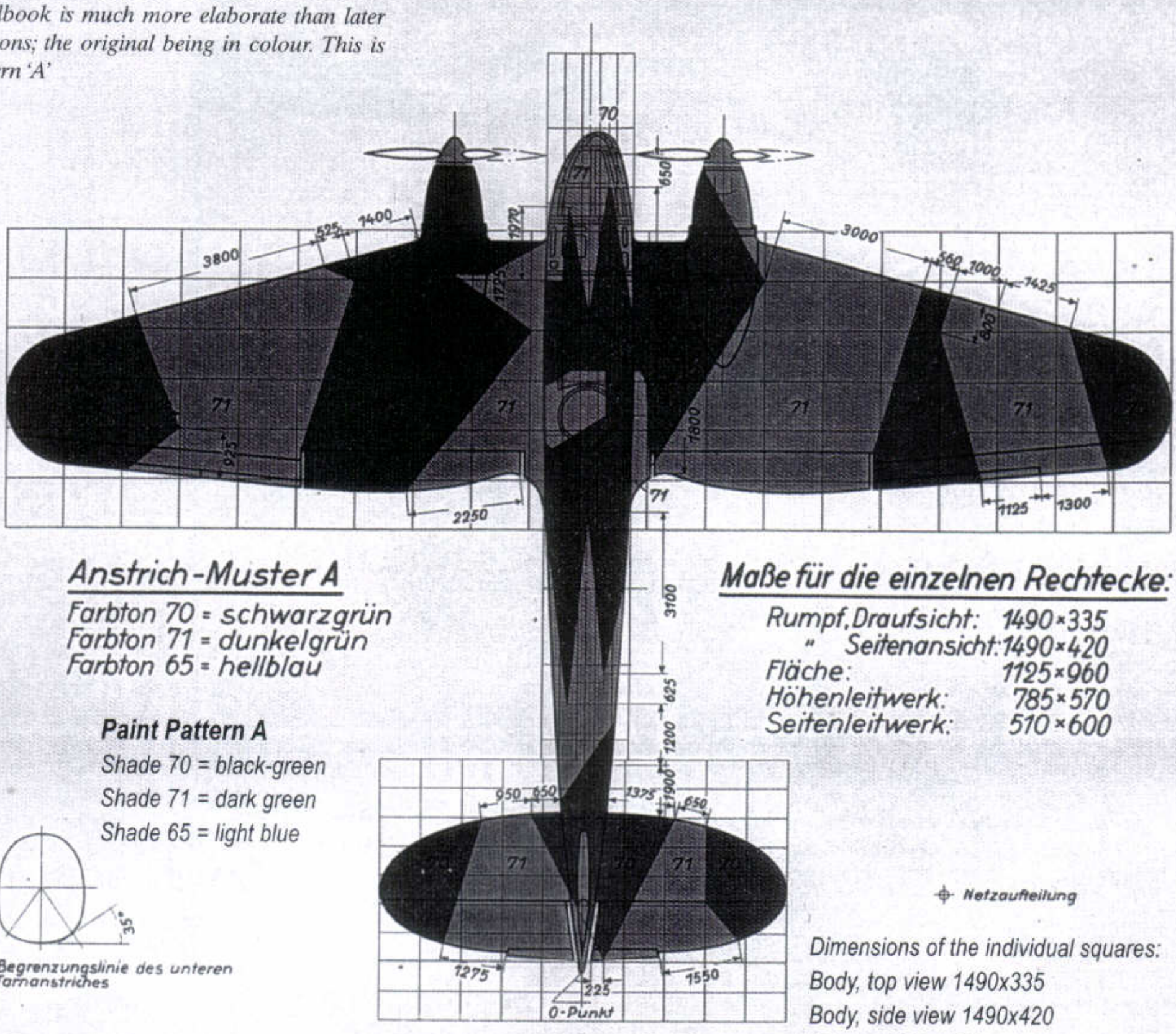


17: Extract from the aircraft handbook for the Henschel Hs 126, approximately lifesize, showing camouflage Pattern 'B'. Pattern 'A' was the mirror image. The original page folded twice, down to A5 size

Sichtschutzschaubild B

18: *This extract from the Heinkel He 111P handbook is much more elaborate than later versions; the original being in colour. This is Pattern 'A'*

Draufsicht

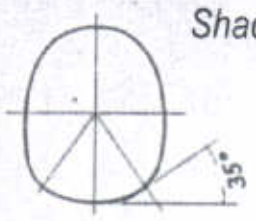


Anstrich-Muster A

Farbton 70 = schwarzgrün
Farbton 71 = dunkelgrün
Farbton 65 = hellblau

Paint Pattern A

Shade 70 = black-green
Shade 71 = dark green
Shade 65 = light blue



Begrenzungslinie des unteren Tarnanstriches

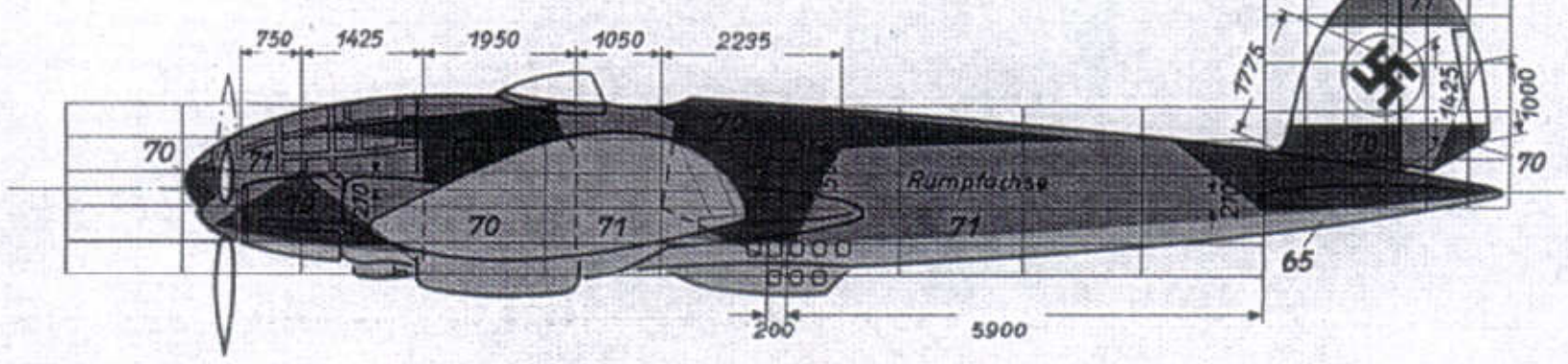
Maße für die einzelnen Rechtecke:

Rumpf, Draufsicht:	1490×335
" Seitenansicht:	1490×420
Fläche:	1125×960
Höhenleitwerk:	785×570
Seitenleitwerk:	510×600

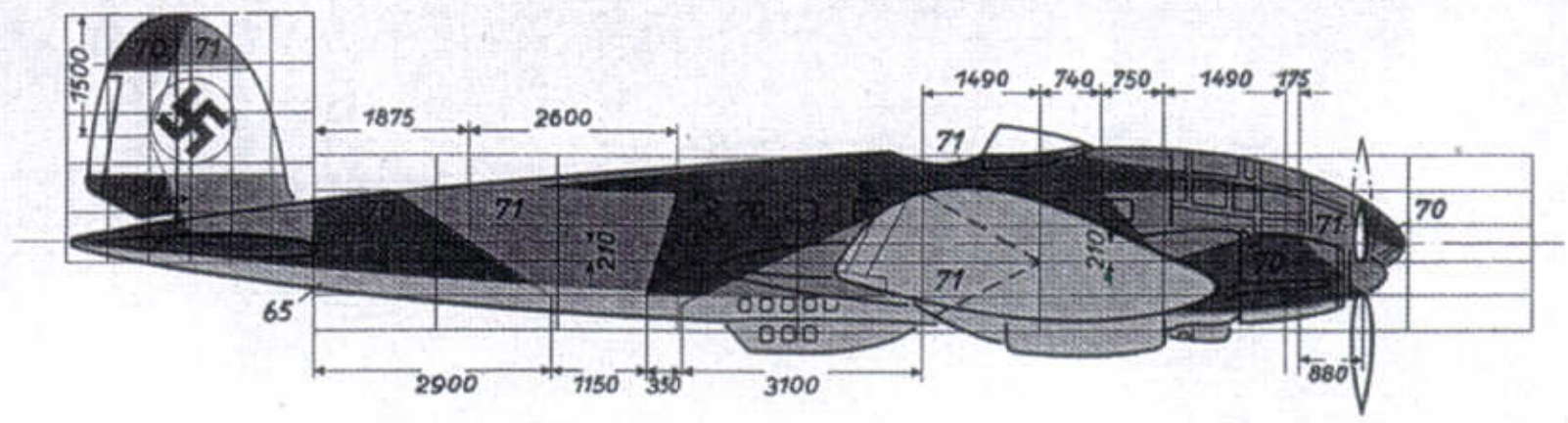
Netzaufteilung

Dimensions of the individual squares:
Body, top view 1490x335
Body, side view 1490x420
Wings: 1125 x 960
Elevator unit = 785 x 570
Rudder unit: 510 x 600

Ansicht von links



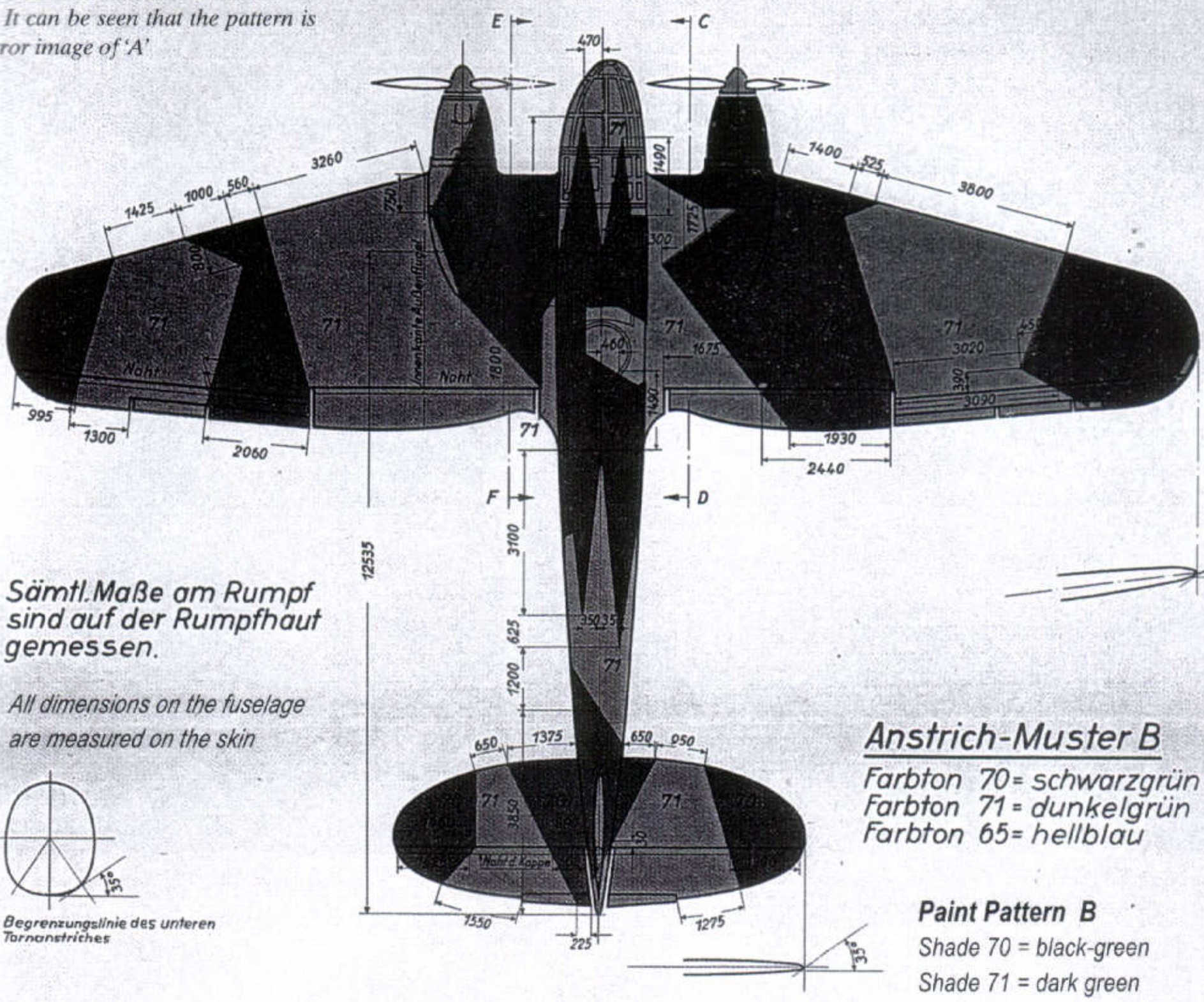
Ansicht von rechts



2 Farben-Sichtschutz He 111 P.

19: *Camouflage Pattern 'B' from the Heinkel He 111P handbook was also in colour. It can be seen that the pattern is the mirror image of 'A'*

Draufsicht



Sämtl. Maße am Rumpf sind auf der Rumpfhaut gemessen.

All dimensions on the fuselage are measured on the skin

Begrenzungslinie des unteren Tarnanstriches

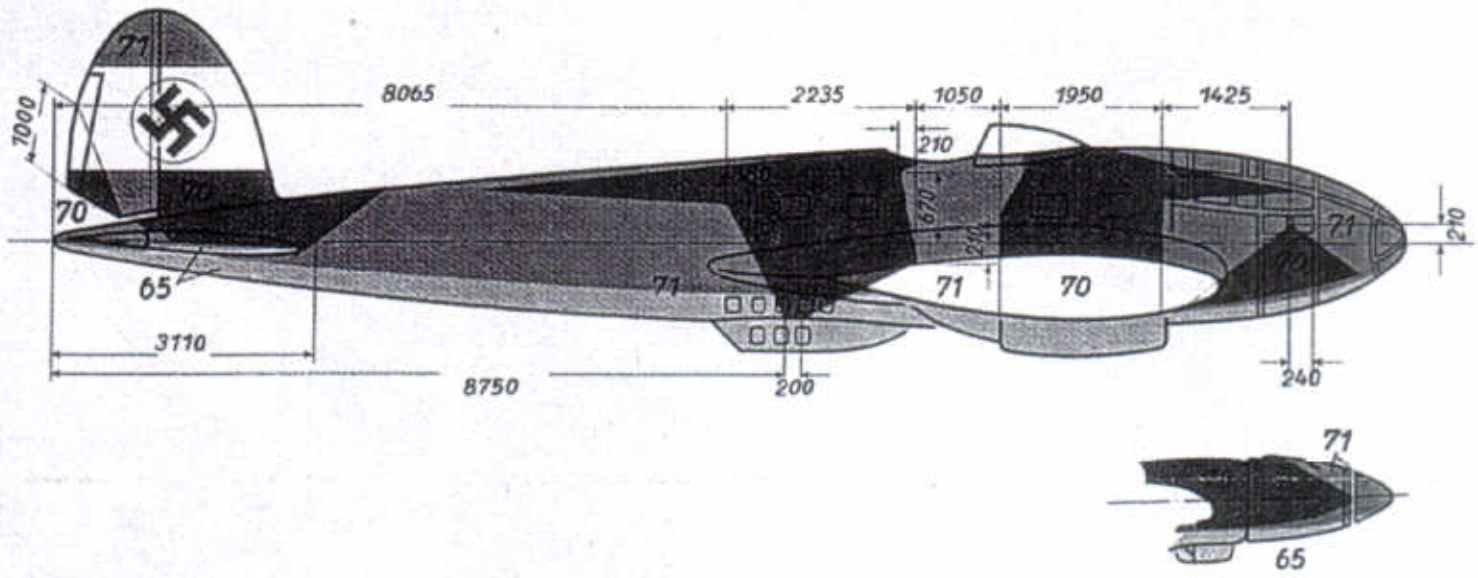
Anstrich-Muster B

Farbton 70 = schwarzgrün
Farbton 71 = dunkelgrün
Farbton 65 = hellblau

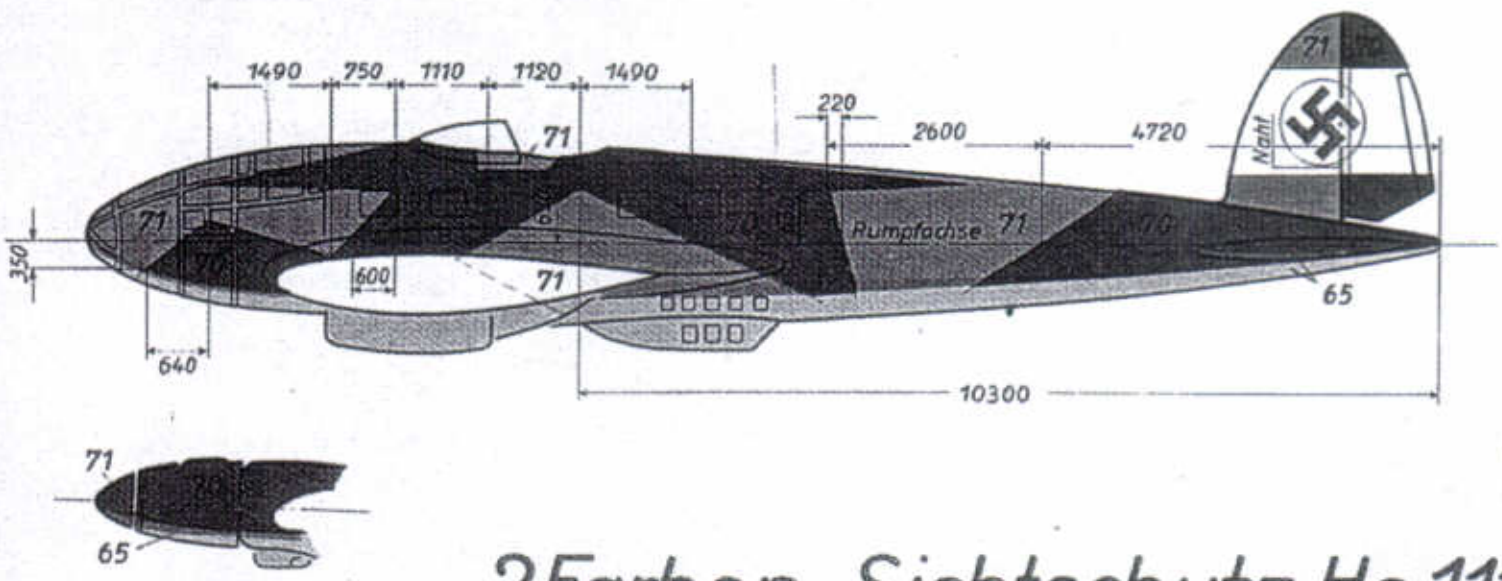
Paint Pattern B

Shade 70 = black-green
Shade 71 = dark green
Shade 65 = light blue

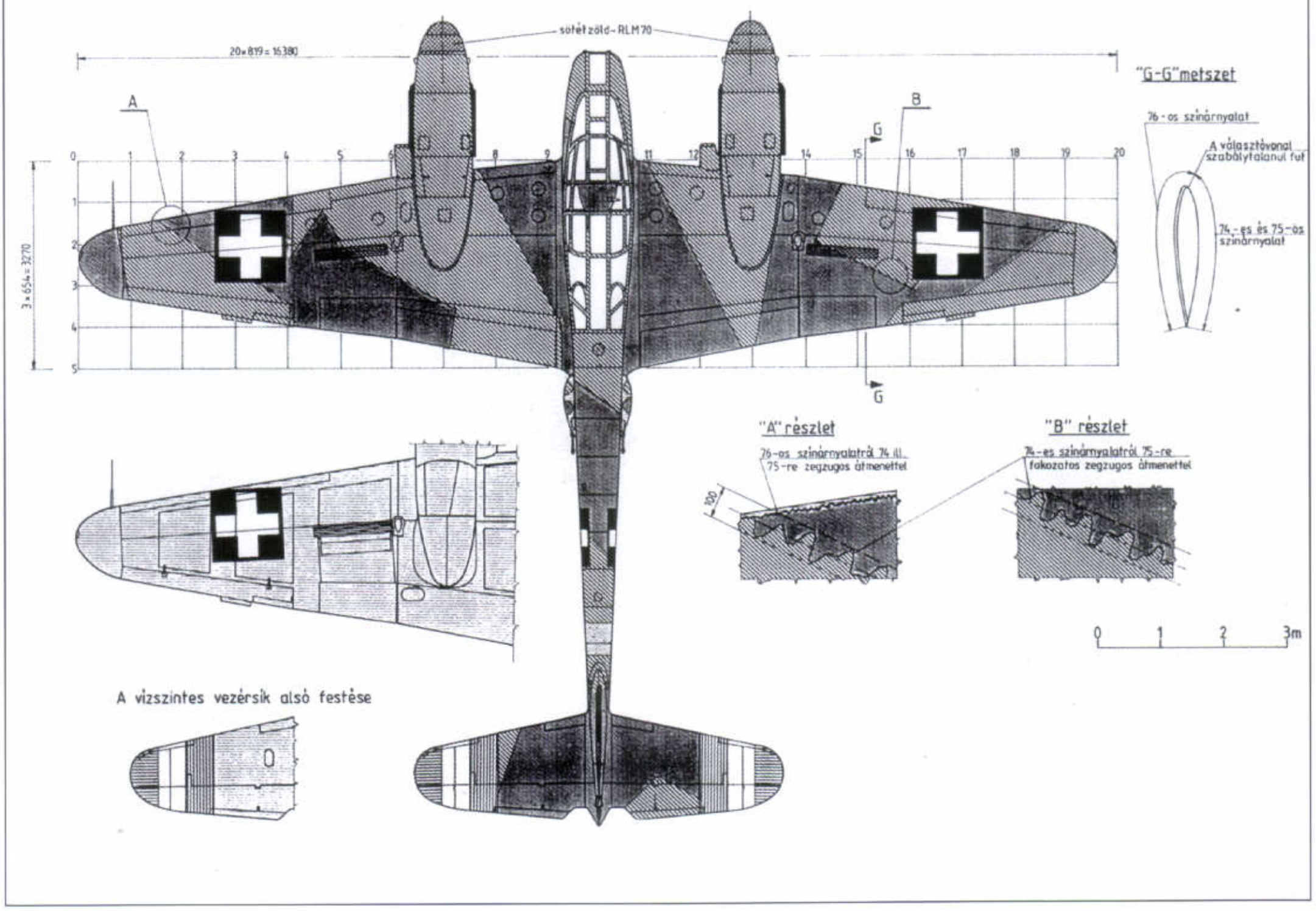
Schnitt C-D



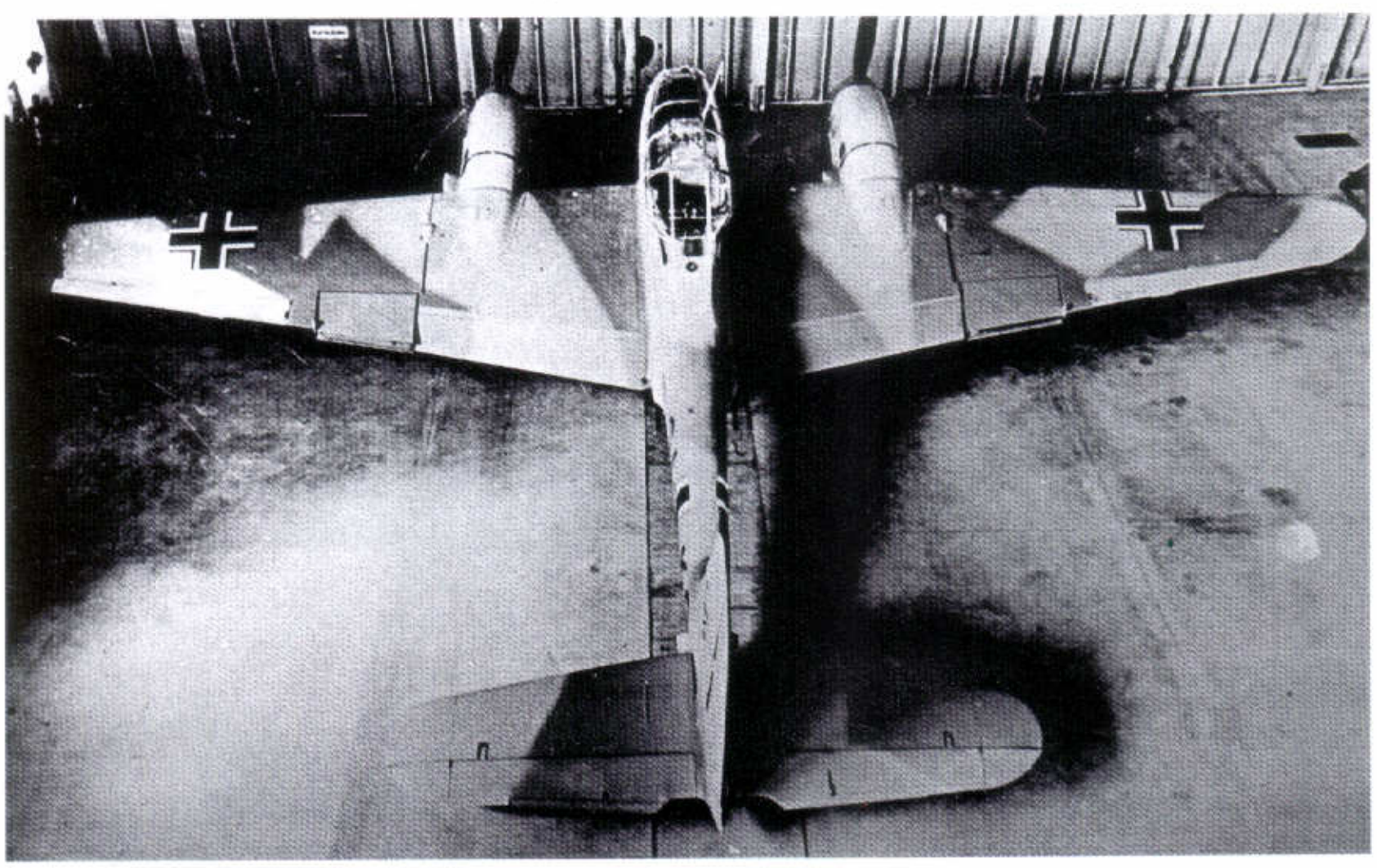
Schnitt E-F



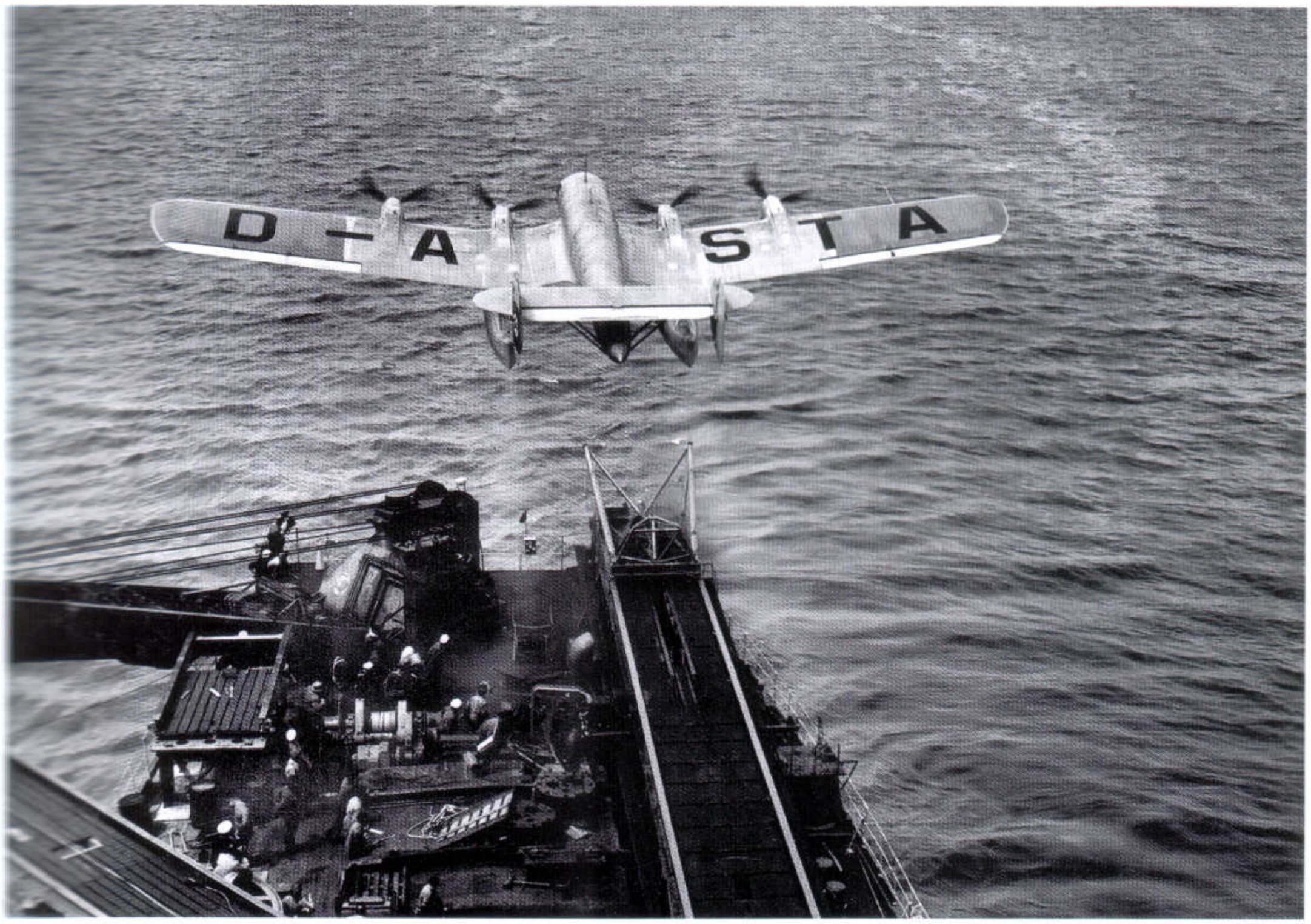
2Farben-Sichtschutz He 111P.



20 Above: *This drawing of the Messerschmitt Me 210 shows the pattern used for finishing aircraft built for the Hungarian air force under licence in Hungary. Based upon the original German drawing, it is identical except for the addition of Hungarian national markings. The Hungarian-built machines wore exactly the same colours as those in Germany, namely RLM 74/75/76, the standard day fighter colours until 1944. Note the size of the marking grid and how the merging of the colours is to be achieved*



21: *Although this is a well known photo of a Me 210, it nonetheless gives a perfect sample of the pattern of 74/75 on the top of the Me 210, showing it to be an almost exact match for the drawing above. Note style of the Balkenkreuze on the wings with a thin white border*



PAINTS 1935-1945

Lufthansa and Zeppelins

The previous chapter dealt with the development in time of paints from various companies. Because of the technological superiority of the Ikarol protective paints for light metal, the basic material used in aircraft, this paint had by 1939 thrust all others from the market. Only in exceptional cases (such as dope or non-flammable lacquers) were paints from other manufacturers still used. It has already been shown that companies that previously competed were producing Ikarol protective coatings under licence. The following sections show how these paints were used.

Lufthansa

Lufthansa is of particular interest because to some degree it used the same aircraft as the Luftwaffe and these aircraft were also treated with the same surface protection processes and paints. There are, however, also significant differences from the Luftwaffe. This is evident from a quotation from a letter from the Lufthansa South Atlantic District Management in Las Palmas dated 19 August 1937:

> "All Do 18 aircraft and D-AKYM are painted above water with DKH lacquer, bronze medium grey and under water with IKAROL coatings. In the experience gained here, these paints have not only proved their worth but IKAROL paints are also the most favoured of those applied by hand".

The parallels in paints between the Luftwaffe and Lufthansa can be easily explained; both aircraft users naturally wanted to treat their aircraft with the best paints and surface protection available at that time. Since the choice of suppliers was of course limited by this quality requirement, the same manufacturer was always used. The comparison between the Lufthansa list and L.Dv 521/1 of 1938 is therefore especially interesting because of these parallels. The following listing is dated 27 October 1936 and is entitled: *Composition of the most important paints kept by DLH and their use. Status 1.11.1936.*

22 Above: *D-ASTA, the Blohm & Voss Ha 139B (V-3)* Nordstern, *at the point of release from the stern catapult of the depot ship* Schwabenland, *gives a perfect view of the finishes used on the airframe. All three aircraft of the type built for DLH (Deutsche Luft Hansa) were finished to DLH specifications, although each differed slightly in appearance. Here, the machine appears to be finished in a well-worn L40/52 grey on the fuselage and centre section, with L40/51 yellow outer wing panels, while the moving flying surfaces appear to be finished in L40/52 silver. The floats are in Ikarol 103/1 grey, with the underwater portions being Ikarol silver 111/s*

Description	Hazards Category	Factory Reference	DLH Reference	Use	Instead of
DKH Nitro-enamel, Duralgrau	I	L40/52	015V054	He 111 metal parts	New
DKH Nitro-enamel, RLM Grau, Bronzemittelgrau	I	L40/52	015V056	Supplied only to special order	
DKH Nitro-enamel, Schwarz	I	L40/52	015V057	He 70 engine mountings, cylinders, etc	Avionorm Paint 015V123
DKH Nitro-enamel, Grau	I	L40/51	015V058	He 70 exterior finish	Avionorm Paint 015V120
DKH Nitro-enamel Silber	I	L40/52	015V053	Jumo engines and aircraft exteriors	Avionorm Paint 015V126
DKH light metal lacquer (oil primer)	II	W 30/01	015V061	Primer	White primer 010V001
DKH oil top coat DLH Grau	II	W 30/23	015V062	Ju 52 exterior finish	Enamel shade 54, 015V030
DKH oil lacquer Rot	II	70/13	015V063	National markings	
DKH oil top coat RB Grau	II	W 30/23	015V066	Ju 52 Rb exterior finish	Enamel shade 53, 015V031
DKH oil base, Hellgrau	II	L 40/41	015V040	Primer for exterior finish	White primer 010V001
DKH thinner for oil base	II	L 40/40	050V095	For oil base only	
DKH single thinner	I	E 52/50	050V100	For nitro-enamels and nitro-paints	Avionorm thinner 050V004
DKH thinning oil (oil paint thinner)	II	W 30/00	050V005	Use for 015V061, 015V062 and 015V066	
Ikarol instant Aluminium lacquer	I	142	015V035	Ju 52 and other exterior finishes	Aluminium coloured enamel 015V033
Ikarol undercoat I Grau	I	103/1	015V160	Special paint for three coat systems, government aircraft	New

Description	Hazards Category	Factory Reference	DLH Reference	Use	Instead of
Ikarol 1-coat paint DLH Grau	I	132/1	015V162	Experimental paint Ju 160 exterior, possibly Ju 52 later	New
Ikarol paint RLM Grau	I	103/2	015V163	Special paint for government aircraft	New
Ikarol paint Silber	I	110	015V164	Under-water paint 10 for Wal	New
Ikarol top coat Silber	I	111/s	015V165	Under-water paint 10 for Wal	New
Ikarol single paint-Grau paint	I	132/3	015V166	Ju 160, Ju 86, Ju 52, He 111 interior finish except for cockpit	New
Ikarol cleaning agent	I	R 100	060V099	For washing down leached out parts of Ikarol coatings (Zoellner or Tepag stripper)	Kasika washing agent 060V092
Ikarol single thinner	I	104/107	050V015	For thinning all Ikarol products	New
Ikarol primer	I	L 201	010V050	For priming Ikarol paints. DKH primer can also be used	New
Cellesta dope or base coat red	I	1603	020V001	Dope for fabric	
Cellesta top coat DLH Grau	I	2000/67	020V010	10 to Wal	
Cellesta top coat Hellgelb	I	2000	020V013	Surface 10 to Wal	
Cellesta top coat Duralgrau	I	2000/91	020V015	He 111 fabric surfaces	
Cellesta compensating fluid	I	1611	020V020	For thinning Cellesta lacquers	
Cellesta top coat neutral	I	1606	020V021	10 to Wal	
Cellesta washing agent (formerly thinner)	I	2437	050V002	For removing old paint, not for thinning	
Elastodurlack Schwarz gloss	II		015V001	Landing gear markings, engine mountings, etc.	
Elastodurlack Schwarz semi-gloss	II		015V006	For Townend rings and NACA hubs only (to avoid dazzle)	Partly instead of Kasika lacquer 015V002

Description	Hazards Category	Factory Reference	DLH Reference	Use	Instead of
Stove enamel, Schwarz semi-gloss	II	9354	015V004	Cylinders	
Blau lacquer	II	32 RAL	015V100	DLH aircraft	
Gelb lacquer	II	23 RAL	015V101	DLH vehicle markings	
Grau lacquer, air drying	II	9551/3	015V110	Hornet housing	
Weiss lacquer, rub-down enamel	II	T 410	015V014	Aircraft toilets	
Chromegrün, identifying colour	I	L 9241/2'37	015V083	Pipes	Protol lacquer 015V092
Chromegelb, identifying colour	I	L9237/5	015V084	Pipes	Protol lacquer 015V093
Braun, identifying colour	I	L9239/82	015V085	Pipes	Protol lacquer 015V094
Blau, identifying colour	I	L9240/68	015V086	Pipes	Protol lacquer 015V095
Rot, identifying colour	I	L9238/9	015V087	Pipes	Protol lacquer 015V020
Thinner for the above	I	L192/s/98	050V019	Pipes	Protol thinner 015V020
Wermalin Grau matt spray paint	I		015V042	Instrument panels, instruments	
Wermalin Grau gloss spray paint	I		015V042	Instrument panels, instruments	
Wermalin Schwarz matt spray paint	I		015V043	Instrument panels, instruments	
Wermalin Schwarz gloss spray paint	I		015V045	Instrument panels, instruments	
Grün marine paint	II		030V001	For preserving Dural etc.	
Shell preserving oil	III	54	030V022	For preserving unpainted engines	Zoellner mist 030V020
DKH oil drawing putty	II	L 40/45	040V009		New
DKH oil putty thinner	II	L 40/00	050V096		New

Description	Hazards Category	Factory Reference	DLH Reference	Use	Instead of
DKH nitro-drawing putty	I	L 40/43	040V011	Thinned with single thinner	Avionorm drawing putty white 040V002
Special putty for black jacket prop			040V007	Wood improvement	
Thinner for the above			050V010		
DKH grinding paste		L 40/60	025V018	Finishing nitro-coatings - He 70	Avionorm Polishing paste 025V015
DKH polishing fluid		L 40/61	025V017	Finishing nitro-coatings - He 70	Avionorm Polishing fluid 025V014
Ikarol grinding paste		S 713a	025V019	For polishing Plexiglas	New
Ikarol polish			025V020	For polishing Plexiglas	New
Tepag stripper	III		060V090	All aircraft	
Zoellner Universal stripper	III	L 9801	060V094	All aircraft	
Ikarol stripper	I	127	060V100	Provisionally not used on DLH	New
Samun stripper, cleaning agent only	I		060V093	For cleaning engine parts	

There is one further special feature of the Lufthansa paint schemes that should be noted; namely the yellow paint on the upper surface of the aircraft wings to make it more visible from the air in the event of an emergency landing on water. The following quotations show that this lacquer was used in practice on Lufthansa flying boats. Here, again, there is a link with the Luftwaffe. In the pre-war period they too bore the yellow top coat on the upper sides of the wings (see the comments on L.Dv 521/1 1938 and 1941 editions on page 84).

From the travel report *With the Do 18 Zephir Dornier Flying Boat over the North Atlantic* by Captain Joachim Blankenburg, of 7 September 1936:

"From half way up the mountain where the house stands, we can see our Dornier flying boat, the *Zephir*, down below protected by the mole. With its sleek, grey hull and yellow wing colour..."

Again, in a letter from Lufthansa, Travemünde, dated 27 September 1938 to the South Atlantic District Management in Las Palmas:

"Further to your above letter we now provide a list of Ha 139 colours most frequently used here.

If the information is insufficient, please obtain the paints list from TE for aircraft type Ha 139 issued by Hamburger Flugzeugbau GmbH:

Hull, interior:
Oil base DKH light grey L40/41
Nitro paint DKH silver grey L40/51

Plating, exterior:
Oil base DKH light grey L40/41
Nitro enamel L40/52

Wings, upper side, plating:
DKH oil base L40/41
DKH nitro paint Lufthansa yellow L40/51
DKH enamel L40/52

Floats, underwater:
Ikarol light metal primer 201
Ikarol paint, grey 103/1
Ikarol paint silver 111/s"

The above table goes on to mention the following coatings used by Lufthansa:

"Cellesta light yellow 2000 for use on: surface 10 to Wal."

Only the upper side of the wings was painted, not the control surfaces. The documents quoted above therefore

prove that Lufthansa flying boats were actually provided with a yellow coat on the upper sides of the wings.

Light metals and their protective paintwork

At the outbreak of the Second World War, Lufthansa did not cease to exist. A number of Lufthansa documents tell us how the company's aircraft were painted during the war. The Quarterly Technical Control Report for July to September 1940 contains the following text:

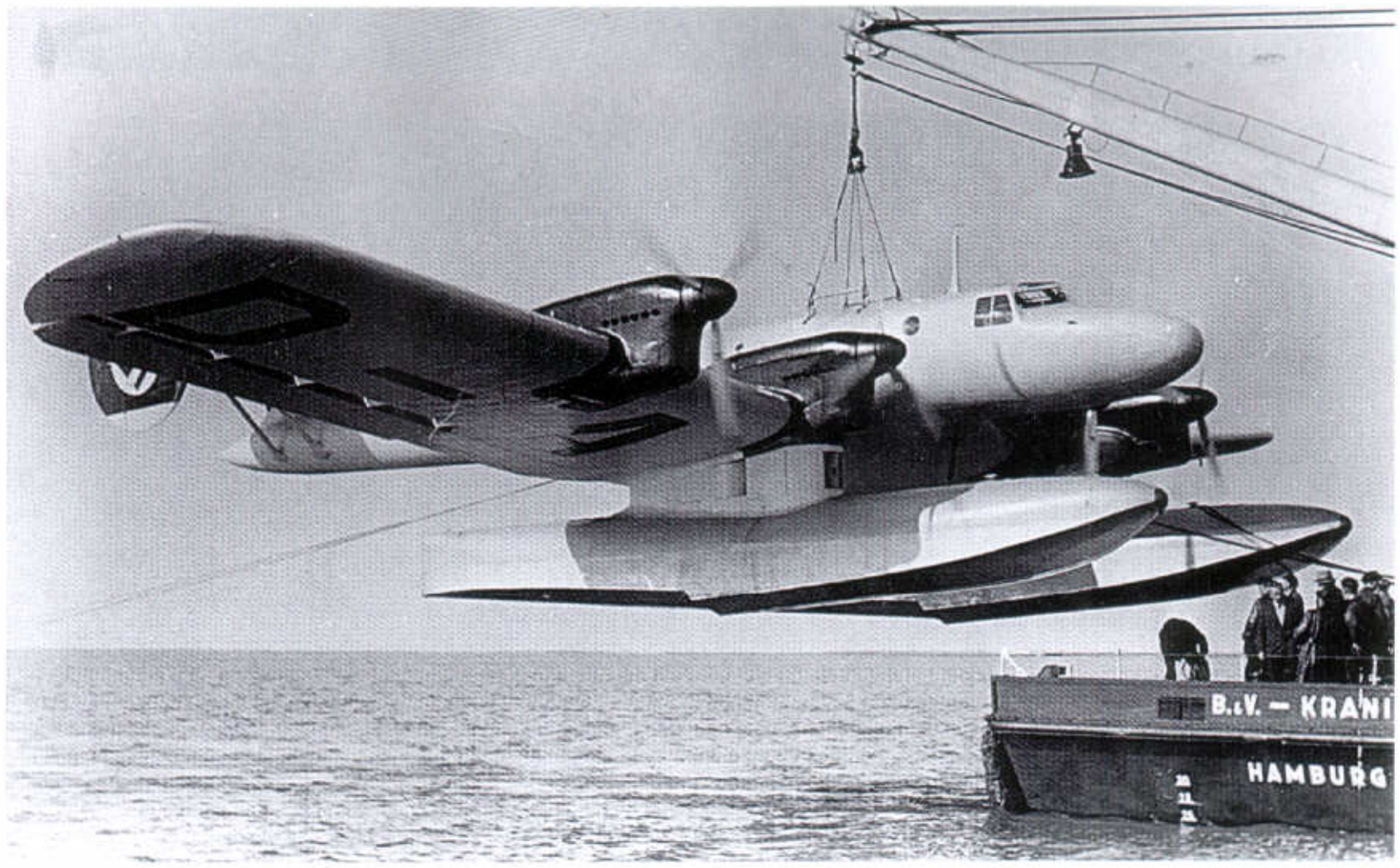
> "Investigations of the storage of lacquers and colours and their use by the individual DLH service units have indicated that it is possible, and also desirable having regard to more economic distribution and storage, for the number of lacquers and colours kept by DLH to be substantially reduced by uniformly prescribing a particular lacquer or a particular lacquer group for a particular use.
>
> .... When selecting lacquers, the following aspects were taken into account. Since DLH extensively services Reich aircraft and has almost all the lacquers and lacquer groups earmarked for Reich aircraft in store, the Regulations where possible included the so-called aviation lacquer systems used on Reich aircraft although the shade 01 silver, which is little used for Reich aircraft, has been adopted as the exterior coating for DLH machines. This has the advantage that the same primer, the same undercoats and the same thinners as for painting Reich aircraft can be used for DLH paints, which means further simplification in storage. In addition, the ingredient base for these lacquers has been so selected that, as we have already found in practice, they are also available in sufficient quantities even under difficult supply conditions. For purposes where aviation lacquers do not exist or are unsuitable, only such lacquers have been included as have either proved their worth over the years in DLH operation or have shown adequate weather-resistance and sufficient tolerance with other lacquers in laboratory tests.
>
> The following should also particularly be mentioned: although the Reich at present has all its land-based machines sprayed with the single lacquer 7122 from Messrs Warnecke & Böhm in order to save labour and materials, single lacquers will not be used for the exterior coating of our aircraft in consultation with TE, a point repeatedly discussed in recent years. A one-year weathering trial at Staaken has in fact shown that compared with the two coat systems from Warnecke & Böhm and Dr. Kurt Herberts, weathered single paints from Warnecke & Böhm, Herbig-Haarhaus, Dr. Kurt Herberts and Ruths are no match for the resistance of two coat lacquers. Since, additionally, the two coat lacquer from Doctor Kurt Herberts proved on this occasion to be inferior to the two-coat lacquer from Warnecke & Böhm, only this latter two coat system, comprising aviation lacquers 7102 and 7109 will be used in future for painting the metal exteriors of DLH aircraft. For the under-water parts of our marine aircraft, the same primer and coatings will be used, but with undercoat 7106 from the same firm, as a three-coat system.
>
> .... For interior metal painting, with the exception of cabin fittings, etc., aviation lacquer 7122 was generally earmarked for land-based aircraft, which is applied to the Eloxal dipping paint for anodised parts. For marine aircraft, either the combination of Eloxal dipping paint and aviation lacquer 7122 or the two-coat aviation lacquer group from Warnecke & Böhm, shade 02 RLM Grau, will be used for anodised parts. For coating wooden interiors, aviation lacquer 7140 will be used from Herbig-Haarhaus, but the combination of Zoellner rub-down lacquer and top-coat will be retained for the neutral painting of hand-wheels and similar parts.
>
> While the lacquers used in the past will for the most part continue to be used for other purposes, especially also for painting instruments and engine parts, a single lacquer will be used instead of the highly varied lacquers adopted for painting national markings, ornaments, lettering, cabin fittings, toilets and luggage holds in aircraft and ground appliances, which will be kept in store in all necessary shades. A lacquer of this kind must have a good gloss and a certain density.
>
> ... The identification colours from Beck, Koller & Co. permitted by RLM as an aviation lacquer and prescribed for painting national markings, for example, are unsuitable for DLH purposes, except for marking pipes which should be treated as in the past, since they are matt and the shades are unattractive.
>
> ... Hitherto, oil paint, nitro-cellulose and artificial resin lacquers have on occasion been used relatively arbitrarily for national markings, cabin fittings, etc. according to the personal preferences of the individual master painters, but they are not individually compatible, which has made alterations difficult."

A further excerpt from the Technical Control Quarterly Report from April to June 1941:

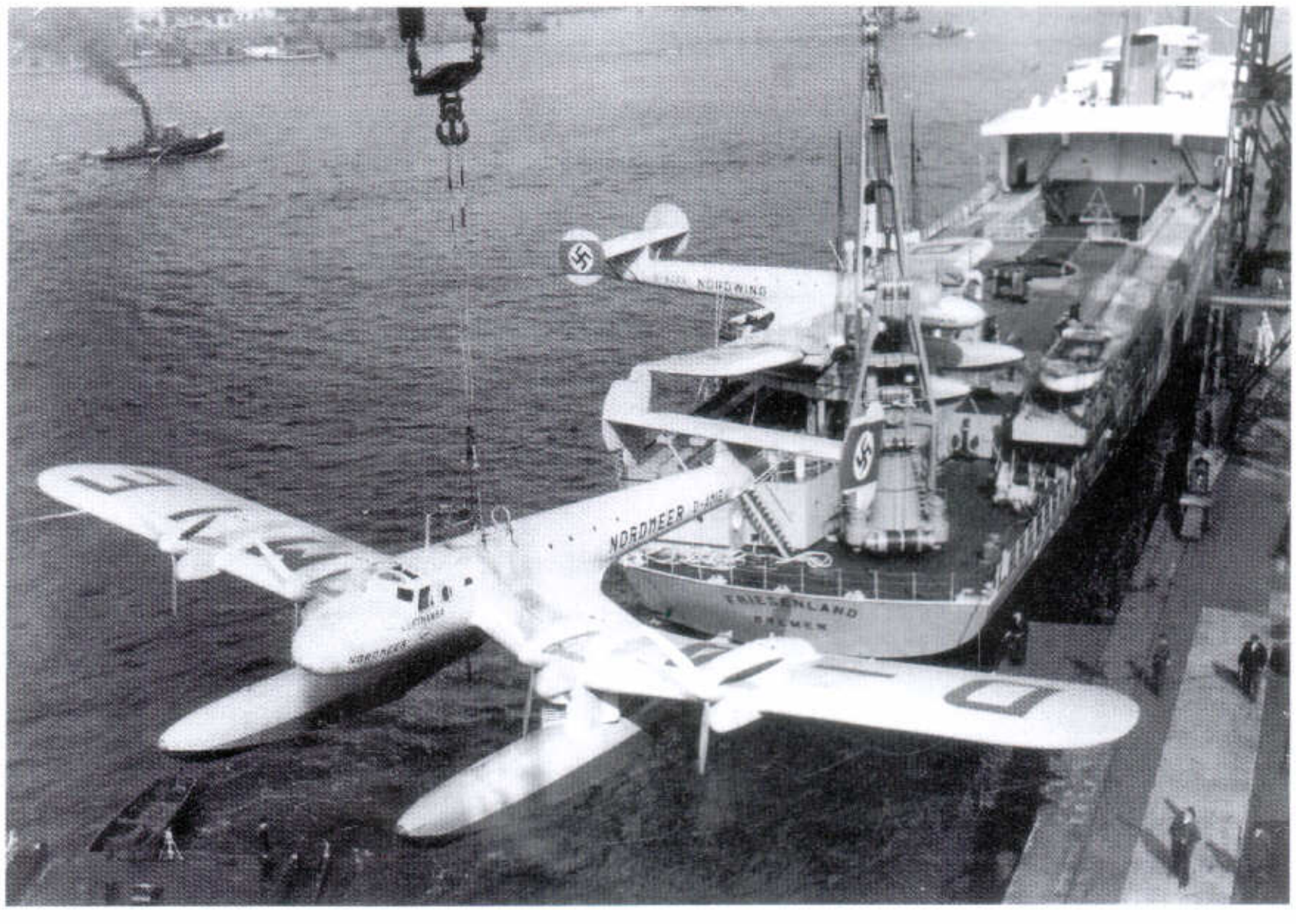
> "A change occurred amongst lacquers and colours in that, while so far every shade of a lacquer has had its own part number, in future every lacquer – as with aviation lacquers (Author's note: the aviation material number) – they had only one part number, while to identify the shade of the part number either the shade number under L.Dv 521 for the majority of lacquers or the RAL colour chart 840 B2 shade numbers for nationality markings and ornamental lacquers or shade numbers on the Wilbra List for leather colours will be added."

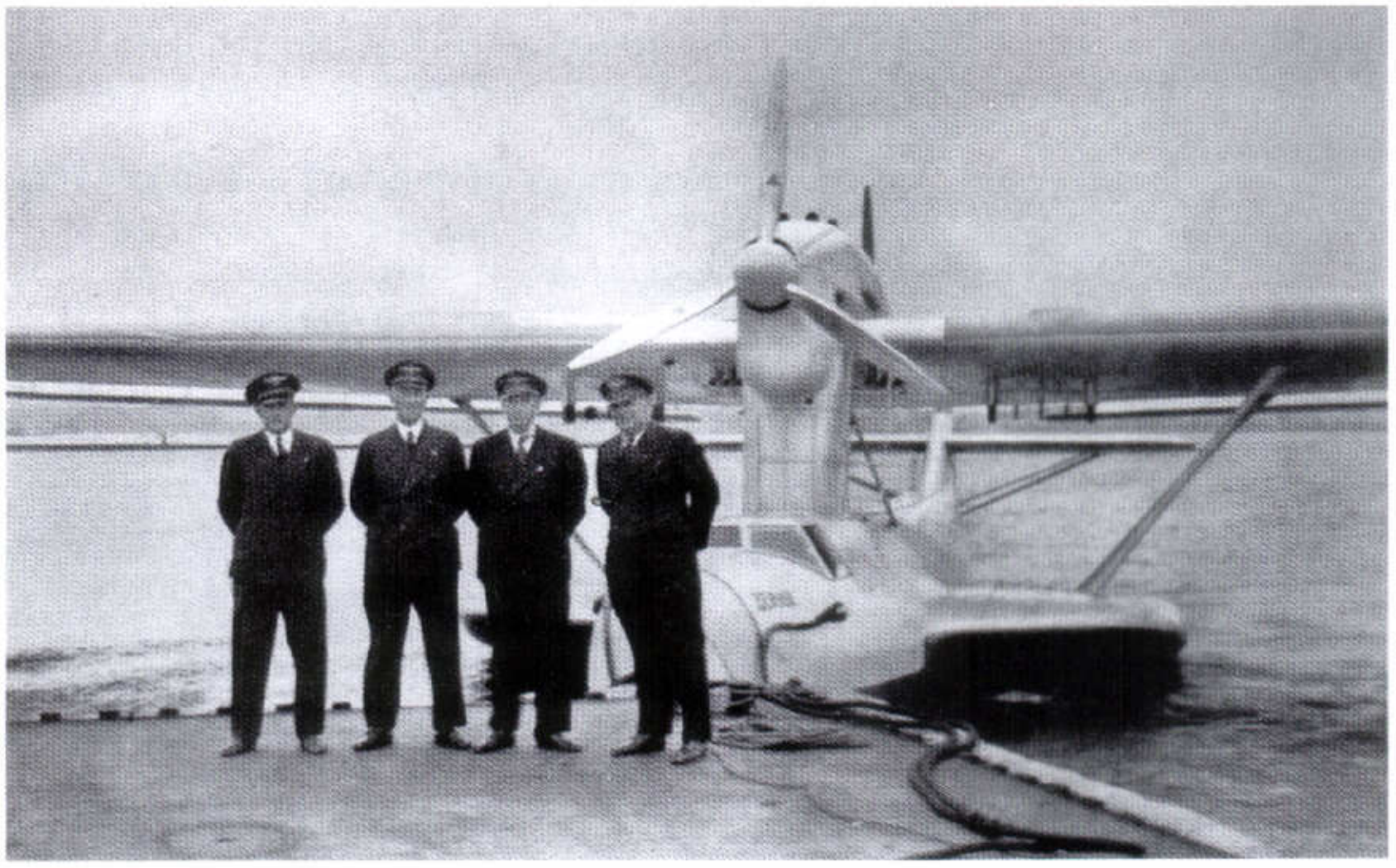
23: *The one and only Caspar C35 Priwall in Lufthansa service. The aircraft served only briefly with the airline; from April 1928 until July 1930 when it was destroyed in a crash. Considering the age of the aircraft, the poor durability of the contemporary paint finish is apparent. Compare the very worn grey paint with that of the Do 26 on page 28. The interplane stuts appear to be either black or a weathered dark grey. The civil registration is in the standard style for the time*

24: *The first Blohm & Voss Ha 139, D-AMIE, 'Nordmeer' is finished in the pre-war light grey L40/52, and is seen probably sometime in early 1937, shortly before it was delivered to Lufthansa. The underwater portion of the floats can be seen to be finished in silver, while the engine cowlings appear to be black, the typical finish for Lufthansa aircraft of the time. In fact this was the only one of the the three aircraft of the type built with cowlings so finished. The aircraft represents a perfect example of the use of aircraft paints in this period*

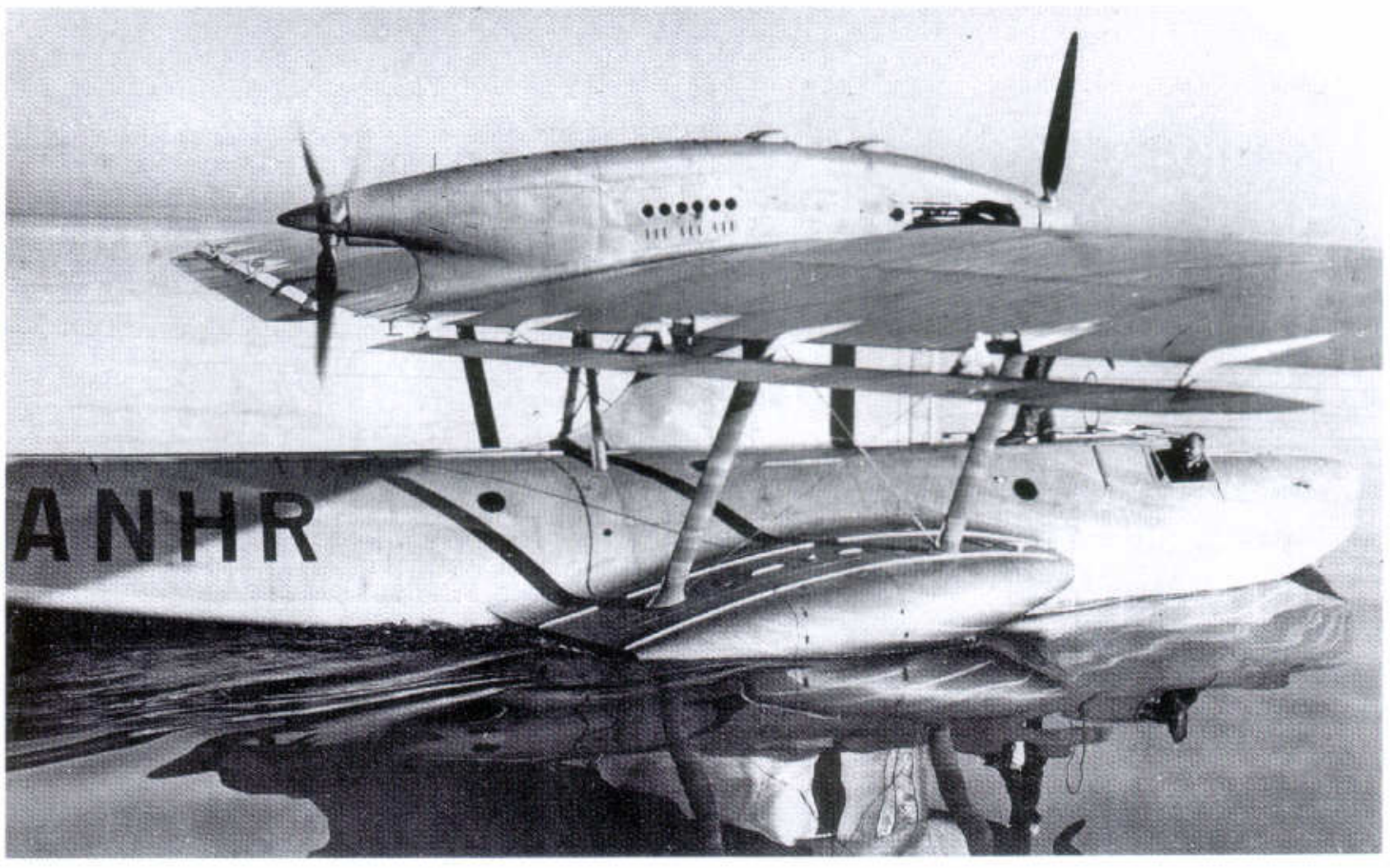


25: *Two Blohm & Voss Ha 139s of Lufthansa painted in the pre-war light grey. The underwater part of the floats was painted in silver (refer to Lacquer Group 03 on page 205). Not so easy to see is that large parts of the upperwings of both aircraft are painted in yellow. This is in accordance with Lufthansa regulations (see page 25) and was introduced to make an aircraft on the water after an emergency landing more visible to a search and rescue aircraft. In their early years the Luftwaffe also adopted this practice (see page 85)*

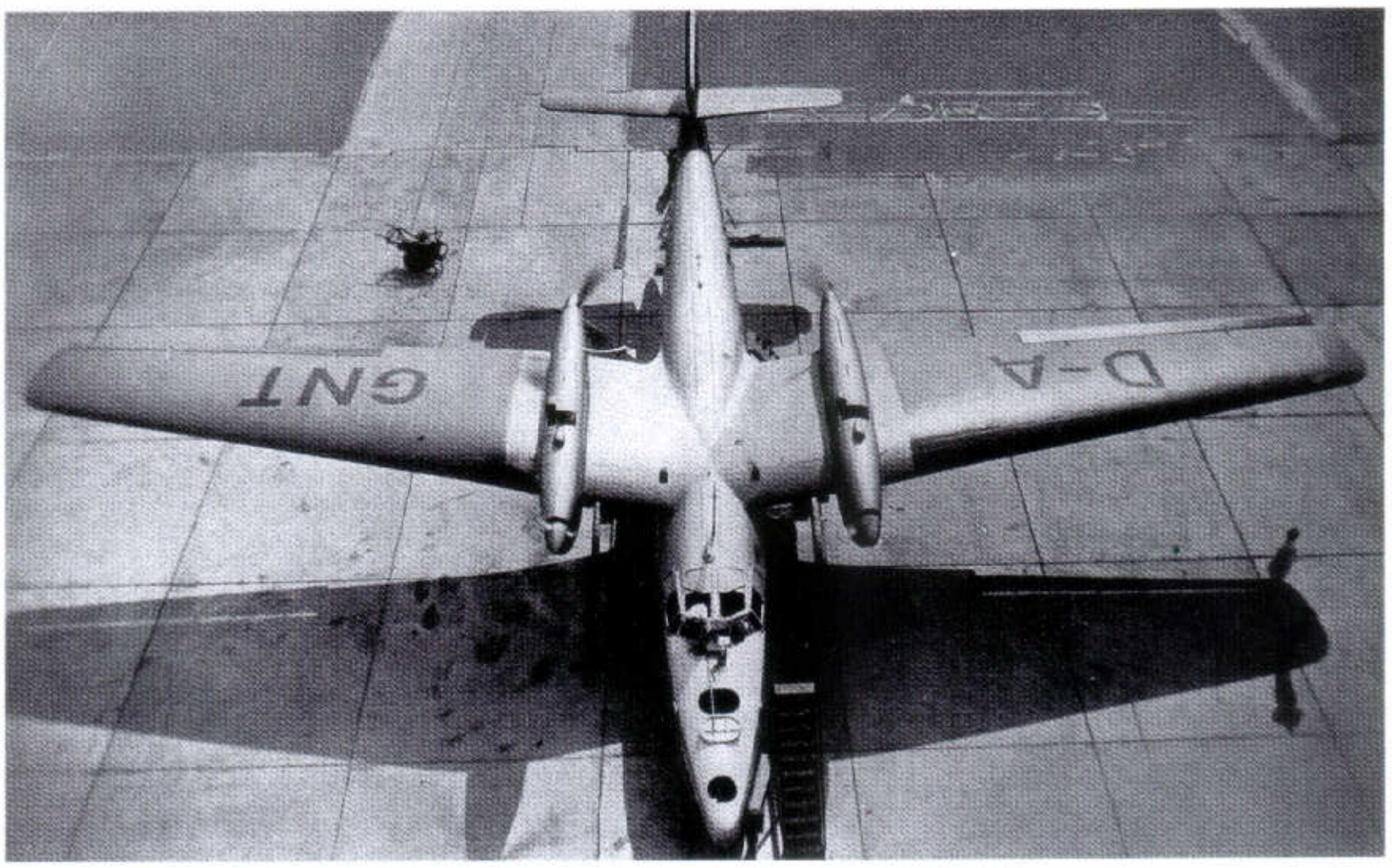




26: *This picture shows the Dornier Do 18, D-ARUN,* Zephir, *at her moorings with her crew in front. The yellow on the wing upper surface is clearly visible on the leading edges, while the rest of the aircraft above the waterline is finished in Hellgrau L40/52. The Ikarol Silber 111/s (see page 25) used below the waterline is also visible*



27: *Moored on the tranquil waters of Lake Constance near Friedrichshafen, this Dornier 18F is painted in the pre-war light grey with the underwater parts of the fuselage painted in the required silver. The aircraft has a very clean appearance, suggesting that the picture was taken shortly before an acceptance test flight and delivery to the customer (Lufthansa). This was the only one of this sub-type to serve with the airline and was not named. The aircraft later made a record-breaking flight of 8392km between Plymouth in England and Caravellas, Brazil, on 27-29 March 1938*

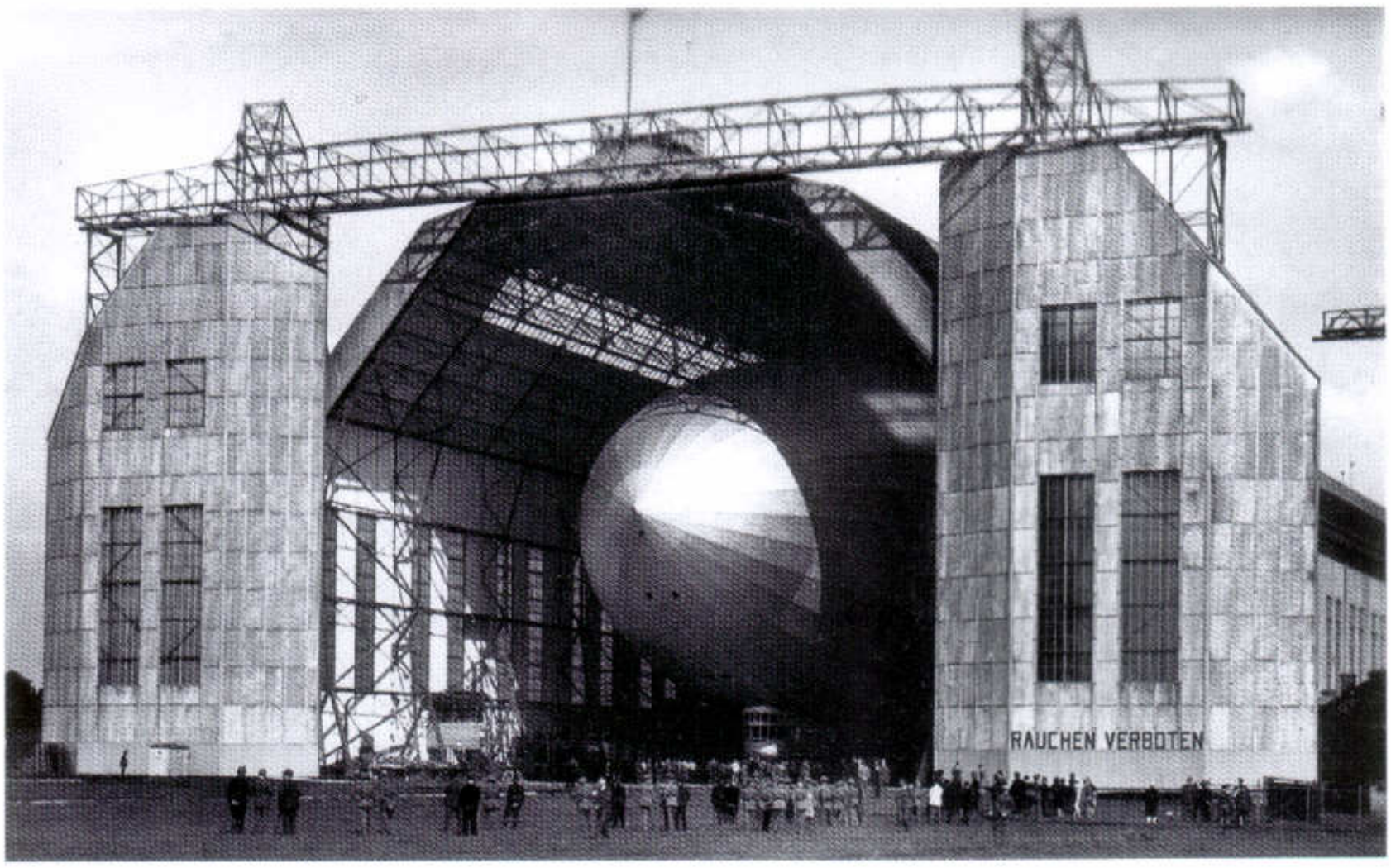


28: *Seen in late 1938, this is the Dornier Do 26V-1 flying boat, D-AGNT, named* Seeadler. *One of only two of the type to enter service with Lufthansa before the war, the yellow paintwork on the upper sides of the wings used on the Lufthansa flying boats to make the aircraft more easily seen from the air following an emergency landing is clearly shown. All six of the type built later served with the Luftwaffe in the reconnaissance and transport roles*

29: *A Lufthansa Junkers Ju 52/3m, D-AFYS, named* Gustav Doerr, *in pre-war grey (probably L40/52, as it appears too bright for RLM 02). The civil registration complies with the regulations as set out on page 146 and the pre-war swastika in the middle of the fin meets the requirements as shown on page 148. This aircraft had a long life, first entering service in 1933 as D-2490, and lasted until 1941*

30: *This civil-registered Junkers Ju 52 was one of a large number operated by Lufthansa on behalf of the RLM to support the Legion Condor's operations in Spain. It appears to be finished in the 'military' RLM 02 (see page 23) with entirely standard registration and national markings of the time. It appears that almost all Junkers 52s in grey finish also had the black engine cowlings and wing bands to disguise oil and exhaust stains*

31: *This is D-AETA,* Westfalen, *(WNr 2484), the first Focke-Wulf Fw 200 Condor to be delivered to Lufthansa (in 1937). It is seen here in Spain in 1938-39. The aircraft is clearly finished overall in silver lacquer (Ikarol 015V035?) with black striping and lettering. The swastika on the fin is in accordance with the regulations. The aircraft enjoyed a remarkably long life as it survived until 1945 and the end of the war—and was still probably one of the most modern airliners in the world*



32: *This picture of an unidentified Zeppelin airship shows the shiny finish of the 'Cellon' (see page 33) on the nose cone to advantage. As the finish weathered all too rapidly, in this picture it has probably only recently been applied.*

33: *LZ127,* Graf Zeppelin, *discharging water ballast over some unfortunate members of the crowd watching as the vessel is manoeuvred to its mooring mast. The dull finish to the envelope reveals how dull and weathered the protective coating quickly became, as related on page 34*

34: *Another view of LZ127 on the occasion of its first water landing on the Bodensee. Compared to the picture above it is clear that the coating is already heavily worn and dulled and the enormity of the task of recoating the envelope after weathering is immediately apparent. Note the national markings applied in accordance with the regulations described on page 147*

Efforts to achieve increasingly more standardization in the paint sector continued uninterrupted. The following is the unabridged painting specification of Lufthansa dated 11 August 1941:

"TE/TK. Dept. Construction Materials and Fuels
Dr. 51/Wo
Staaken, 11 August 1941

Explanatory notes on the painting specification for DLH aircraft, engines, instruments and ground equipment

The painting specification drafted after extensive discussions with all interested parties aims to ensure standardized paintwork of all DLH aircraft, engines, instruments and ground equipment, thereby contributing to a considerable reduction in the number of varnishes and paints stored at DLH and in warehouses. It is being issued particularly in regard to a later labour-intensive change-over to peacetime operations and the extensive demands of such peacetime operations themselves, which make it imperative to use as few paints as possible—preferably of a standard, and definitely of a mutually compatible, composition—and which would thus no longer allow the painting of an aircraft to be left to the taste and craftsmanship of individual painters. The painting specification is therefore binding for all DLH departments.

Because DLH will probably continue for some time to overhaul military aircraft and Reich airliners, the paint list concentrates on aircraft paints, which are also to be used for both military aircraft and airliners in order to avoid increased stock-keeping, but also above all—due to the current scarcity of raw materials, which in our estimation will continue into the initial peacetime period—because these paints are manufactured almost exclusively from local raw materials and will always be available in sufficient quantities. In the selection of paints exclusively for DLH aircraft the raw material situation was also considered. For this reason the oil paints, oil varnishes and oil-based synthetic resins hitherto preferred by DLH could no longer be included; this is no disadvantage, however, even if it should require some painters to alter their application techniques, because the newly developed paints have a more uniform consistency and perform better than the old oil-based paints, and after the war nobody will be prepared to spend foreign currency on such antiquated paint raw materials.

The painting specification therefore contains some innovations:

The numerous nitrocellulose oils and synthetic resins used hitherto for painting national insignia, lettering, decorative markings, parts of the cabin interior etc., have been replaced by a single product, the Bekoloid cellulose gloss enamel, which offers the following advantages: it is suitable for spraying, brushing and dipping, it is compatible— according to our extensive tests —with other coatings of the painting specification and provides very good resistance to weathering; it dries quickly to form an ample covering with a beautiful gloss finish. The lacquer is available in all colour shades of RAL List 840 B2 (if required, also in the colour shades of LDv 521). Intermediate shades for repairs can easily be obtained by mixing different shades of the paint.

Furthermore, oil paints, such as the egg-shell and finishing varnishes of Messrs. Zöllner, used hitherto for neutral coating of wooden parts, have had to be replaced for reasons of raw material shortages by another paint. As a substitute the so-called Emaillola cold glaze, a cold-hardening Bakelite varnish has been chosen. This has already been successfully used for years by the Heine Propeller Works for varnishing wooden propellers in a natural-wood finish. With proper application the Emaillola cold glaze provides a glass-hard ample coat with a nice matt or gloss finish. It has the advantages of being an excellent preservative and of being as good as impervious to all solvents etc. The application specification for this varnish is available upon request from TE/TK.

The green marine paint of Messrs C.W. Schmidt, Düsseldorf, which has hitherto been used for preserving bare metal components, not least during transport, can also no longer be supplied because of raw material difficulties. It has been replaced by the green-glaze anticorrosion paint 141 of Messrs Warnecke & Böhm which, following extensive testing, has proven to be clearly superior not only to the green marine paint, but also to all other paints tested at the time.

The aim in future must be to persuade the manufacturers of new aircraft intended for DLH also to use as their surface finishes only those materials listed in the painting specification. For the transition period the painting specification contains in the "Repairs" column details of paints which, according to our tests, are suitable for repairing the paintwork used by suppliers of new aircraft. If there is no entry in this column, the aircraft concerned can simply be repaired with the top coating of the relevant new paint system. Obviously the information in this column applies to repairs only. Any aircraft or aircraft components which have been stripped must always be preserved using the paints listed in the "New Coating" column.

In addition to specifications on the paints and varnishes to be used for repairs and for new finishes, the "Painting-Specification" also contains short instructions on their application (spraying, dipping, brushing), the thinning process and the thinning ratio as well as the drying times. The information has been taken in part from LDv-521 and in part from the suppliers of the materials. In some cases no definite details could be obtained. In these instances application must be left to the expertise of the painter concerned.

The 'Painting Specification' contains all aircraft paints and their reference numbers, as well as those with the new DLH part numbers, which come into force on 16.8.1941. An important difference compared to hitherto is that while each individual shade of a paint has previously had its own part number, only the paint/varnish itself – similar to aircraft paints – is now assigned a part number. The colour shades are specified, e.g. when ordering, by a shade number which, as with aircraft paints, is added after a dot to the part number of the relevant paint. The shade numbers used are those contained in LDv-521, as commonly employed with aircraft paints, the exceptions being Bekoloid cellulose gloss paint, for which the shade number of RAL Table 840 B2 is used, and the Wilbra leather paints which are governed by the shade numbers of the Wilbra list. These exceptions are necessary because the LDv shade list is geared to the requirements of the Luftwaffe and thus does not contain all the shades needed for the decorative enamels and leather paints of civil aircraft. For administrative reasons the aircraft paint numbers as well as the DLH paint numbers should be preceded by the material group specification. Material group C.908 has been assigned for "chemicals, coating materials and fuels". When ordering, enquiring etc., the part numbers should be quoted according to the order examples given below:

908/7122.02	for single-coat finishing paint FI. 7122.02 in shade 02, RLM Grey, as per LDV 521/1
908/80 641.01	for Bekoloid – cellulose protective paint 12 429, in shade 01, Silver, as per LDV 521/1
908/80 300.23	for Bekoloid – cellulose gloss enamel, in shade 23 yellow, as per RAL 840 B2
908/80 460.11	for machine paint, blue-grey (DIN 1842)
908/80 871.5	for Wilbra leather paint, in shade Havana brown, as per Wilbra list

While our aircraft remain in natural metal finish in peacetime, or are painted externally in silver shade 01, for camouflage purposes their exteriors are to be painted in RLM grey shade 02 during the duration of the war.
As operational experiences are to be taken into consideration in future reviews of the painting specification, observations regarding incompatibility, insufficient weathering resistance, application difficulties etc. of individual paints, as well as any desired modifications, should be addressed without delay to TK/BB with a copy sent to TK/FLG. It is requested, however, that only proposals for changes supported by detailed technical reasons be submitted."

The above excerpts from the Lufthansa document provide an abundance of very interesting detail from Lufthansa's view. But note the following:

- Reich aircraft and reference to the Reich. This always means Luftwaffe aircraft. The use of this term deserves special attention since in this context no reference is made at all in the document to the war or hostilities.

- The use of aircraft lacquers and paints systems in accordance with L.Dv 521/1 for Lufthansa. The description of shades under the RLM is also adopted. However, departures were quite deliberately made from L.Dv 521/1 in accordance with Lufthansa's instructions (the use of gloss for other paints).

- The last paragraph of the first quotation also indicates an attitude that workshop personnel were given to adopt in painting Lufthansa aircraft. It is worth noting that the situation has been mentioned in an official letter. This is all the more significant, since, as the war progressed, the Lufthansa specialists were called up to serve with the Luftwaffe. Why should these specialists then suddenly change their "personal preferences" and strictly paint the Luftwaffe aircraft to regulation standards?

Surface Protection for Zeppelins

From the beginning of the 20th century until the Lakehurst disaster Zeppelins had been an important symbol of German aviation technology.

The main components of Zeppelin construction, duraluminium and cotton, were each given suitable surface protection. This was to prevent the aluminium from corroding. The cotton was stretched, made impermeable to water and protected against harmful ultraviolet rays.

In a table of components and materials used in the construction of Zeppelin airships it specifies that the Dural frame is to be painted with a cobalt blue varnish in order to increase its weather resistance. For this purpose precise specifications were laid down. The following is a copy of the "Specifications for the Preservation of Airship Components" released by the Luftschiffbau Zeppelin GmbH works at Friedrichshafen and dated 25 October 1935.

In the technical description of the LZ 129 *Hindenburg*, the chapter on the envelope describes the application of the Cellon coating. This application is termed "Cellonising":

"The entire envelope of the ship's hull and the tail surfaces are given 5 coats of Cellon. Each coat is applied by brush. There is no sanding of the envelope. The individual coats consist of:

Specifications for the Preservation of Airship Components

Material	Pre-Treatment	Preservation Agent	Method of Application	Drying Time (hours)	Temperature
Dural	wash in perchloro-ethylene or trichloro-ethylene, wash in hot water	DKH paint	immerse spray	8-10	18-20°C
Elektron	steep	Titan white Asopil paint	brush brush	8-10 6	18-20°C 18-20°C
Steel	sandblast	cadmium plate Zyklop aluminium bronze	galvanize brush	8-10	18-20°C
Welded parts sleeves	wash in P3 bath	cadmium-plate	galvanize		
Threaded parts in fittings	wash in P3 bath	Vaseline	coat		
Pivoted parts		cylinder tar (Legonal B.E.)	brush		
Envelope, Cotton & linen		cellulose stiffening dope with 2% iron oxide cellulose with 4-5% aluminium pigment	brush (1 coat) brush (3 coats)		

1st coat of Cellon + 1.5% iron oxide
2nd coat of Cellon + 3% aluminium powder
3rd coat of Cellon + 3% aluminium powder
4th coat of Cellon + 3% aluminium powder
5th coat of Cellon + 2% aluminium powder

The total amount of iron oxide + aluminium powder is not to exceed 22 g/m2."

What is Cellon?
Cellon is celluloid dissolved in acetone. This "liquid plastic" is still available today, albeit in a different formula, and is used on, for example, gliders. As Cellon is highly inflammable, because it is so easily ignited, and as it possesses drawbacks, it has been largely replaced today by more modern two-component varnishes.

If one compares the above "Specifications for the Preservation of Airship Components", dated 25.10.1935, with the description of the "Cellonising" of the LZ 129's envelope, it becomes apparent that the LZ 129 was given an additional coat of Cellon.

It was known that the Cellon protective coating applied to the outer envelope of Zeppelins did not possess a particularly long service life. This is shown, for example, by the technical report of the airship *Hindenburg* for its 43rd and 44th flights from Frankfurt to Lakehurst and back:

"During the flight we experienced several hours of heavy, uninterrupted rain. Water trickled down between the cell plates even in places where there are no channels. It would appear that the outer envelope is already leaking due to its protective coating being washed away."

The problem of heavy water penetration into the Zeppelin, caused by the protective coating applied to the *Hindenburg's* outer envelope apparently having become unserviceable, resulted in a letter, dated 28 October 1936, which was sent by the *Deutsche Zeppelin Reederei* (German Zeppelin Airship Line; henceforth DZR), Frankfurt, to the *Luftschiffbau Zeppelin* (Zeppelin Airship Manufacturers; henceforth LZ), Friedrichshafen:

> "We would request your comments as to whether the presumption that the Cellon can already have been washed out of the envelope by rain is valid. We cannot credit that in the short operating life of the airship the Cellon coating is now already leaking, otherwise the Cellon in its present composition with the waterproofing agent is not yet satisfactory. Quite apart from the unwelcome burden upon the ship caused by the amounts of water which have penetrated, there is also the danger posed to the electrical installations from possible short-circuits."

For Germany's Zeppelins there were a number of problems associated with a protective coating of the outer envelope which needed to be solved:

1. The weight increase of the Zeppelin caused by water penetration. The lifting force of the hydrogen in the gas tanks was limited. This force was also affected by air pressure, ambient temperature and humidity. If a Zeppelin became progressively heavier from water leaking in, it would have problems retaining its altitude.

2. Short-circuits in the electrical installations of the airship caused by water penetration. Here the problem was the arcing, or flying sparks, which might possibly result. Such sparks could ignite the hydrogen gas. When hydrogen gas reacts with the oxygen in the atmosphere it produces 'detonating gas' which, as its name implies, is a very explosive mixture.

3. The roughness of the envelope and the air resistance this produces. For example, the overall surface area of the LZ 127 was 20,000 sq m. If this surface was rough and uneven, air resistance would be increased and this, in turn, would lead to a reduction in speed and higher fuel consumption. It also goes without saying that a rough surface would retain more water.

Attempts to overcome these problems by special measures were undertaken time and again. One example is provided by the following letter, sent by LZ to DZR on 17 July 1937:

"**Protective coating of the envelope**
As a preliminary trial for the future protection of the outer envelope it is suggested that:
The raw material, particularly cotton, should receive prior treatment with a water repellent and smoothing agent on the reverse side of the material. The fine, upright fibres are at present acting as sponges and dust collectors. A protective paint can be added to this agent. Instead of the 6% as hitherto, stretch the lengths of material in a methodical sequence of alternating stretching and release periods to approx. 8% tension = $^2/_3$ of the test elongation-at-rupture point. This tensile extension is not permanent, as the material will immediately begin to creep back until the stretching has been reduced to a small fraction (approx. 10%) of the elongation-at-rupture point.
Brush on a coat of undiluted stiffening dope of improved LZ 126 design, while adding a light ray protective agent (ferrous oxide).
Second coat: as first coat (spray).
Third coat: as second coat, but in place of ferrous oxide, use 25g aluminium powder per 1 litre varnish.
In addition to this, the varnish is diluted with one part thinner to 5 parts varnish. The aluminium powder should be of grade 140, i.e. the powder should pass through a mesh with 55 wires per cm.
Fourth coat: as third.
From Angle 13 across the ridge to Angle 13 a fifth coat of water-repellent wax preparation, similar to that used on automobiles, is to be applied. This is then to be rubbed down and given a second polish. Repairs to the envelope are easy to carry out simply by rubbing off the thin layer of wax with acetone. The protective impregnation of the entire inner area (approx. 10 g/m² film of latex, wax or similar substance), and the external impregnation across the upper part of the ship, does not affect the surface tension. The increase in weight is no greater, as some $^2/_3$ of the fifth coat can be saved.
Of far more importance is the fact that no longer will one or more coats need to be applied every year to preserve the envelope (LZ 129 was given two coats across its upper half after just one journey period). This additional weight would mean a premature replacement of the envelope at no small cost."

But this did not put an end to the search for a satisfactory solution to the surface protection of the outer envelope, as witness this letter from LZ, dated 11 December 1937 and addressed to the RLM's Test Centre:

"**Specifications for Surface Protection.**
As a great deal of research and development work into the surface protection of metals as well as textiles has been carried out in the field of aircraft construction, and as we are still involved in the further development of impregnation processes for the outer envelope of our airships, it would be of great benefit to us, if we could be kept informed of the latest specifications (on this subject) issued to the aircraft manufacturing industry.
Could you please inform us whether you are able to accede to this request."

The RLM's answer to this letter was despatched on 27 December 1937:

"Re: **Specifications for Surface Protection.**
Re: Your letter of 11.12.1937
The above mentioned letter has been forwarded to me by my Aircraft Test Centre, Berlin-Adlershof.
In compliance with your request I am enclosing herewith the specifications for the development of aircraft paints issued by my Technical Office at the end of 1936. Since that time trials with non-flammable paints have been successfully concluded. Firstly, I would refer you to the following products of Messrs. Herbig-Haarhaus, Cologne:
Metal 44 non-flammable
Wood 10 non-flammable
Textile 24 non-flammable
which have 18 months of development behind them and offer perfect paint finishes.
The non-flammable paints of Messrs. Frenkel and of the Zoellner Works display similar properties. But testing of these products has not yet been completed.

In addition, a range of metal paints of purely German manufacture has been tested, of which the 'Aviatin C' system of Messrs. Kotthof, Cologne, and 'Naß in Naß' of Messrs. Beck, Koller & Co, Berlin-Weissensee, could well prove of interest to you.
I would welcome your informing my Technical Office, Dept. LCII (1a), from time to time of your experiences with any new surface protection agents."

Just why the LZ chose not to use the paint systems tested and approved by the RLM for fabric-covered aircraft on their airships is unknown. Perhaps the aircraft paints were too brittle, not flexible enough, for use on the outer envelope of an airship. It must be clear to everyone that the very size of an airship meant that it was never completely rigid. Its joints and bracing were subject to continual movement. If its protective surface was too brittle it could not compensate for such movements and would fracture. Despite the tautness of the envelope, a certain elasticity had to be allowed for. Perhaps it was these very requirements which the raw materials and production processes of the time were unable to fulfil.

The trials continued without interruption and had not been completed even by the summer of 1938, as is shown by these minutes of a meeting which took place on 28 July 1938 between representatives of I.G. Höchst and the DZR:

"Following a discussion held at I.G. Höchst on inert gases, the scientific director, Dr. Kränzlein, described the advances made in the development of paints which could also be used in the painting of our airship envelopes ... At the outset DZR had referred to the inadequacy of the impregnation agent used to date and had pointed out its major faults: the rapid leaching out of the stiffening dope and a deterioration in water resistance. The elimination of, or at least an improvement in, these shortcomings is urgently sought. An improved Cellon, designed to overcome these faults, should be made available to the LZ for the new envelope. But at the same time, in order to maintain the envelope while in service, the DZR requires a suitable softening agent to seal the hairline cracks which appear in the paint and which begin to let in water after the first flight ...."

As a result of the expectations raised by these discussions, a further meeting took place just a few days later. As the following report of 26 October 1938 shows, this second meeting led to yet further activities:

"**Cellon – The Coating of the Ship's Envelope**
On 1 August 1938 in the offices of the Technical Department at the airship field a meeting was held to discuss the subject of improving the stiffening dope and the impregnating paint of the airship's envelope. It was attended by a large panel of interested parties from the I.G. paint industry, Höchst and Ludwigshafen, as well as from the DZR. Dr. Kränzlein referred to a suitable new base material (synthetic), which appears to offer the prospects of eliminating a number of the faults inherent in the Cellon coating to date. As is generally known, I.G. will provide the basic materials, while the Wörwag Paint Factory of Stuttgart-Zuffenhausen has undertaken to process the ready-to-use paint into a commercial product. Yesterday there was an opportunity to discuss the matter with Herr Eugen Wörwag at the airship field, during which he imparted to us the following on the situation regarding the new envelope coating. Tests have been in full swing since September. After some initial failures with the new synthetic on account of its poor solubility, real improvements have since been noted.

Following a series of tests there is now every prospect that the new basic material (synthetic) can be processed into an envelope coating suitable for our purposes. Preliminary trials indicate that the paint produced from the new material is markedly better than the paint used hitherto, particularly in terms of water vapour permeability; on the other hand the stiffening material still appears to be unsatisfactory. The tests are continuing: the first two coats being of the paint used hitherto, two further coats with the new base material, and the final finishing coats again with the improved, tensionable paint previously employed.

Our long-running attempts to achieve a better hull coating for airship construction now appear to be having some success, insofar as LZ has been co-operating for some time with Messrs. Wörwag. As Herr Wörwag reported yesterday, he is visiting Friedrichshafen the day after tomorrow and is taking with him new paint samples on canvas stretchers. He has already made repeated trips to Friedrichshafen over the past few weeks. Herr Wörwag has explained that it is not the paint materials currently in use which is the problem, but that the difficulty lies much more in the application of the paint – particularly the poor access to the areas to be painted and, to an even greater extent, in the amount of dust in the airship shed which is the cause of the hitherto rough paint finish on the envelope.

Messrs. Wörwag have suggested to LZ that 2 further coats should be applied, using a spreading substance, which should help to achieve a mirror-smooth surface. The conversion of shop-floor equipment to achieve a perfect and dust-free application of the paint is currently the subject of in-house discussions at LZ. During the meeting of 1.8.1938 here at the airship field, Herr Jordan undertook to come up with a regeneration paint for the overhaul work. In the interim we have heard nothing further from Herr Jordan; nor have the promised stretchers and paint samples been delivered to us here. Herr Wörwag had the following to say on the matter:
He himself had already worked on this regeneration paint for the LZ 129 and, as a trial, some 50 kg of this

paint had been applied to the nose of the ship. The results were apparently good, and he would now also like to recommend most strongly that the paint be used in the overhaul of LZ 130. If, during the last meeting, Dr. Jordan had held out the prospect of developing such a paint, it must have been a misunderstanding which could only have arisen because he had not been informed of the regeneration paint produced for the LZ 129 by his colleague Dr. Schulze.
The attempts to improve the paint materials on the part of the paint manufacturers, and the efforts of LZ to achieve a better finish now appear to be well underway."

Just how seriously this problem was regarded, and just how important it was to find a solution—especially for DZR—is made clear in this letter of 11 November 1938 from DZR, Friedrichshafen to DZR, Frankfurt:

"Re: **Outer Envelope**
The LZ is currently conducting tests to improve the smoothness of the surface of the outer envelope.
It will probably be suggested that the envelope of the LZ 130 be carefully abraded with fine glass-paper and then to be given two further spray-coats of a normal acetate-cellulose paint. The additional weight would be in the region of 1,000 kg. The expected increase in speed, it is hoped, would offset this additional weight and, above all, reduce the 3,000 kg of fuel required by the water ballast extraction plant during a 75-hour journey time. The empty weight according to Herr Herzog (112,694 tons) would permit the additional weight of the Cellon coating within the terms of the contract.
In this context the next matter to be looked into is whether this 'Cellonising' should be carried out at Frankfurt between journeys, or whether the shed at Löwental is climatically more suitable. An air pressure plant has to be available with 10 connections for gel- and water purification filter hoses, each with a pistol delivering some 50 atü (pressure above atmospheric). In addition there must be a vacuum extractor plant as it is essential that all dust be removed from the shed.
We would request that we be sent several samples of the LZ envelope, each about 20 cm square and cut from several places in the belly, sides and back of the ship, so that we can submit these to the LZ and make the true condition of the envelope perfectly clear to them. Please indicate the exact location from which each sample has been taken, do not crease them, and pack them well protected so that their weights and moisture content can be measured here."

It can be seen that the efforts to improve the surface protection for the outer envelope seem to have been crowned by success at last, as the following letter of 20 December 1938 from the Wörwag paint works to DZR, Frankfurt indicates; only the smoothness of the surface remains the subject of discussion:

"To refer back to the earlier talks between our Herr Eugen Wörwag and your most esteemed chief engineer Herr Rösch regarding the attainment of a smoother envelope. We have, in the meantime, been conducting various tests which have led to a satisfactory result. We are forwarding to you today a sample stretcher. This stretcher has been treated from the surface upwards, just like the airship itself, firstly with 2 thin coats of surface impregnation, and then with 4 coats of envelope impregnation paint 6252 with 2% aluminium bronze. We then gently rubbed down the stretcher with very fine emery paper to remove the most obvious signs of unevenness. Then we applied two further spray-coats with 1% aluminium bronze and 1 coat with .5% aluminium bronze. As you can see from the stretcher, this has produced a completely smooth and clean envelope, which will no doubt have a significant effect on the speed of the ship. This multi-coating of 3 layers has the additional advantage of a long service life. The tension of the envelope is also slightly increased. We would, furthermore, be most happy to conduct small-scale tests on the ship itself.
We await your further comments on this matter with interest."

After the problems regarding the non-durable weather resistance of the surface protection of the outer envelope seemed finally to have been overcome, the search for the causes of the LZ 129 *Hindenburg* disaster at Lakehurst on 6 May 1937 imposed yet more new requirements on the surface coating. The reason why the *Hindenburg* exploded at Lakehurst has still not been fully explained to this day. Was it a bomb, a lightning strike, self-ignition within the ship itself, or what? In fact it was known that, under certain conditions, the outer envelope of a Zeppelin could contain a considerable amount of static electricity. The arcing from the discharge of this static electricity in the outer envelope could have ignited the hydrogen in one of the gas tanks. In order to solve the problem the outer envelope would have to become electro-conductive. And it was to achieve this that the following specification for the 'Cellonising' of LZ 130, dated 4 December 1939, was issued:

"**Procedure for the graphite-'Cellonising' of LZ 130**
Surface to be coated on the inner side of the envelope
Tailcone to circular frame 218, Angle 15-18-15
Circular frames 218 to 246, 15 (mistake in original?)
Angle 16-18-16
Upper control surface
Together approx. 5,300 m2
Mixing of graphite-Cellon paint
When using colloidal graphite (approx. 12 kg available)

100 parts by weight Cellon coating
35 parts by weight colloidal graphite (20% solution in acetone)
No thinner

When using powdered graphite (100 kg ordered 2.10.1939)

100 parts Cellon coating
9 parts powdered graphite
No thinner

1,000 kg Cellon ordered from LZ on 2.10.1939, if possible ⅔ Wörwag and ⅓ Atlas Ago. The two Cellon brands are, as far as possible, to be applied in the same areas in which they were used for the original coating (see envelope diagram).

The longitudinal strips between the ridge angle and angle 16 are to be completely detached from the frame. The blue paint of the framework is to be removed using cotton waste saturated with Cellon solvent, but only from those sectional rods with eyelets for the cordage, in other words the end plates of the triangular bearers. After removal of the blue paint these profile sections are to be given a coat of graphite-varnish (the eyelet profile sections at angle 18). For this purpose 20 kg clear varnish ordered from D.K. Herberts on 2.10.1939. For every 100 parts varnish mix in 9 parts powdered graphite.

The envelope strips are to be carefully detached and, without too much creasing, lowered to the shed floor where they are to be attached upright to a stretcher frame. Then spray or brush as per Items 1. and 2. The paint must be applied carefully and evenly. After 1 day's drying time the strip is returned to the framework and attached by means of envelope cord. This cord must also be graphitized, by impregnating with graphite-Cellon. The tentering machines are attached and the outside of the envelope now evenly painted with the aluminized stiffening and regeneration dope. If possible while still in the wet state, the envelope will be tautened by the tentering machines and the cords fed through. Then remove the machines and sink-stitch at longitudinal beam 17 using graphitized yarn. Now final gluing can be carried out, but no graphite is to be mixed with the Cellon glue.

75 kg varnish glue ordered from LZ on 2.10.1939. The longitudinal strips at angles 16-15 are folded back, so that one strip is doubled back to lie on each of areas 15-14. Longitudinal beam 15 must also be freed, the blue paint removed from the eyelet strap and graphite-varnish applied. Then proceed as above, graphitize and paint the entire ship between longitudinal beams 16-14 with stiffening and regeneration dope.

The envelope of the dorsal control surfaces is not removed, but sprayed or brushed on from within.

For the above, LZ has ordered 1,000 kg stiffening and regeneration Cellon dope and 30 kg powdered aluminium. 15 kg envelope cord ordered by LZ, also 300 running meters of aluminized envelope material for glued tape."

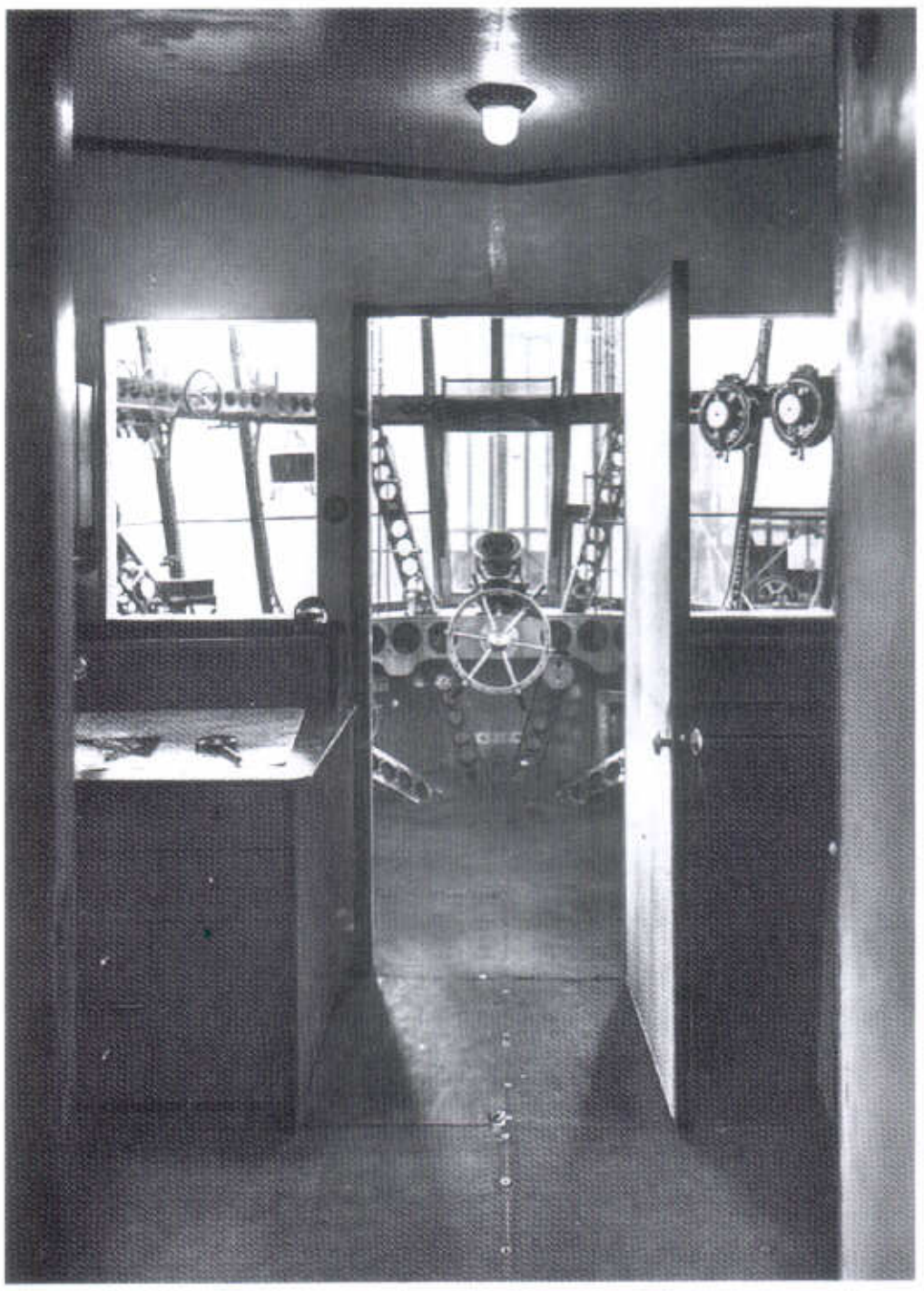
The story ends here with the outbreak of World War II. The last two documents were written after the outbreak of hostilities. The Zeppelins, which would have been in constant danger from enemy aircraft, were now outdated. German airships were especially at risk because of their hydrogen tanks. Those Zeppelins still in existence were scrapped and their components (aluminium, fabric etc.) used in the construction of military aircraft.

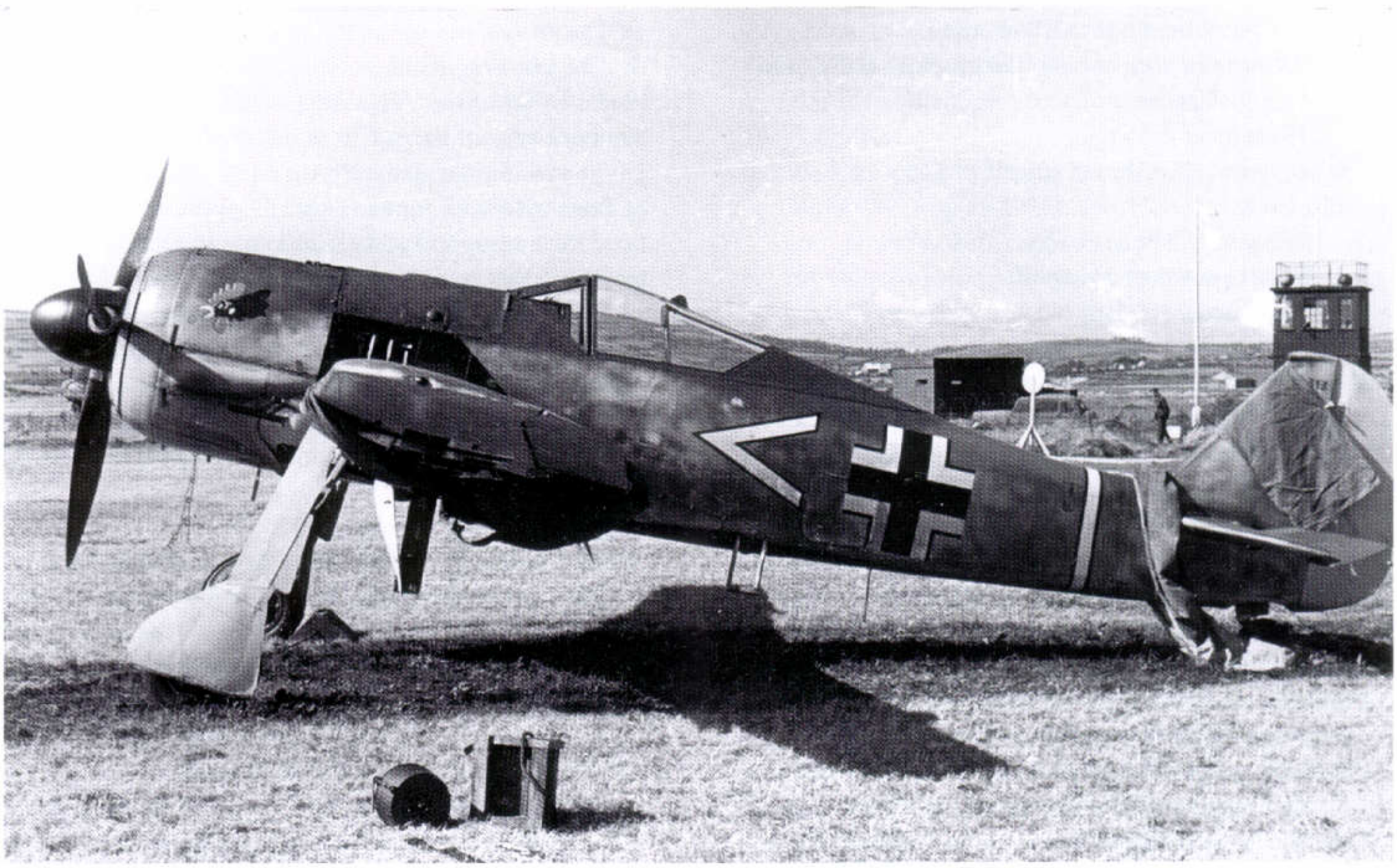
The colours of the Cellon paint used on their outer envelopes were at one time a reddish-brown (iron-oxide pigment) and then aluminium (powdered aluminium pigment, similar to RAL 9001).

The airships mentioned in the text bore the following names:

LZ 127 *Graf Zeppelin*
LZ 129 *Hindenburg*
LZ 130 *Graf Zeppelin II*

36 Below: *A view into the control car of the LZ127,* Graf Zeppelin. *The marine ancestry of the vessel is apparent in the steering wheel, chart table and windows akin to a ship's bridge*





LUFTWAFFE PAINTS 1935-1945

A chronological overview

The period now under consideration was relatively short; from 1935 to 1945 covers only ten years. Everything related to this book's theme occurred within these ten years: creation of the Luftwaffe, expansion into a combat weapon, wartime operations and complete destruction at the war's end.

If we compare this with the US Air Force, for example, whose roots can still be traced back to the First World War, and the difficulties one encounters when researching into the colours used by the US Army Air Force in World War II, one can judge what difficulties are involved with the former German Luftwaffe. These same difficulties, however, also form some of its attractions.

This variegated history is the reason why the available data and documents at the start and demise of the Luftwaffe are few and far between. Initially, on account of the Treaty of Versailles, everything was still strictly secret and done 'on the quiet'. Towards the end, there were more important things than aircraft colours; survival, for example. Subsequently, in any event, most was lost in the chaos surrounding the collapse of the Third Reich.

On account of the restrictions imposed by Versailles, there were few aircraft in Germany in early 1933. Military aircraft were essentially converted civil aeroplanes, the colours were therefore the same as on civil aircraft. The main colours then in customary use were:

Light grey
For example:
DKH (Dr. Kurt Herberts) L 40/52 grey or
Avionorm – Nitro paint 7375 matt grey, and other paint systems.

Silver
For example:
DKH L 40/52 silver or
Ikarol 110 or 111/S (later to become RLM 01 silver)

However, the initial coatings for Luftwaffe aircraft were already soon standardised:

RLM 01	Silber	Silver
RLM 02	RLM Grau	RLM Grey

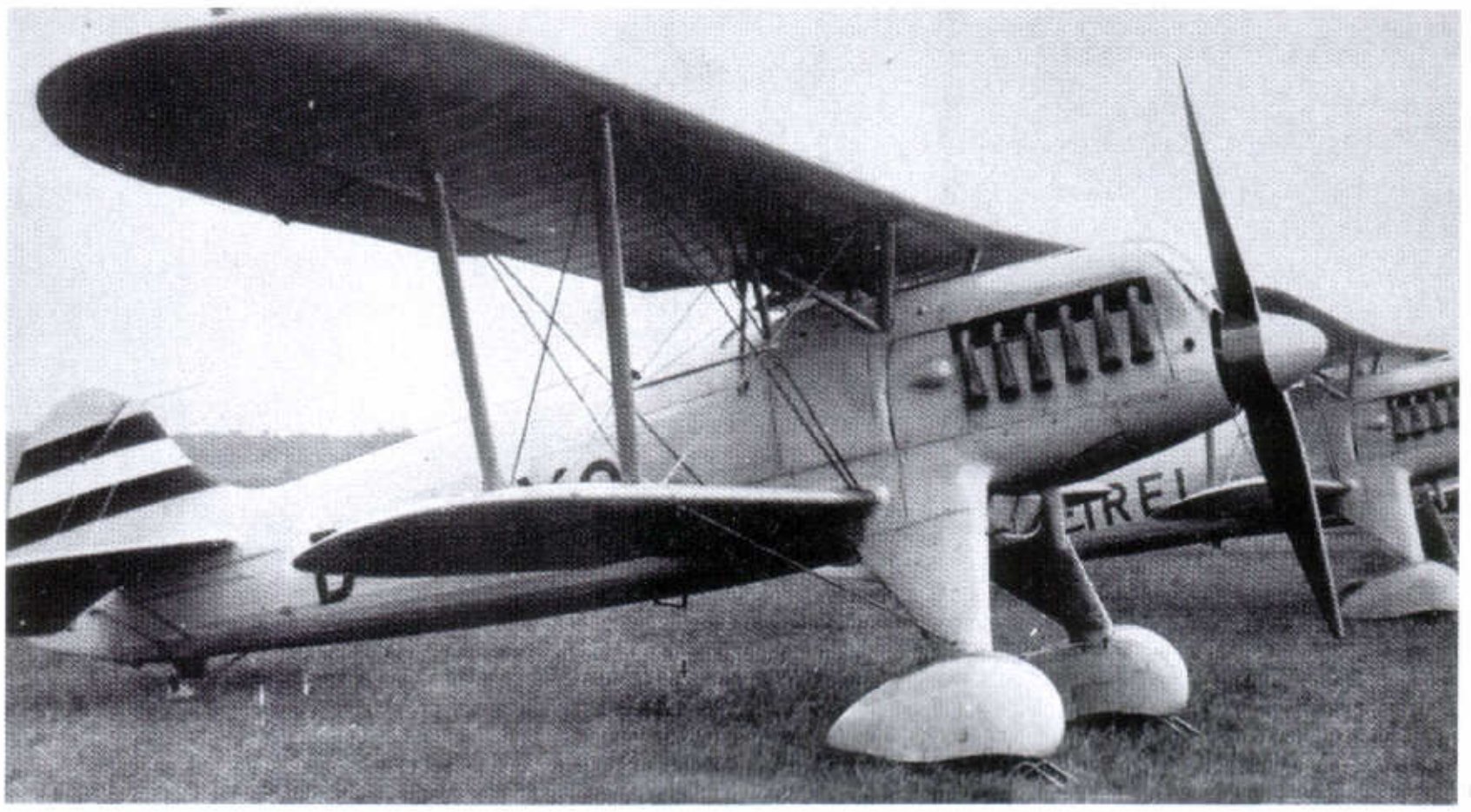
Paints from the early period of the Luftwaffe always give rise to speculation. RLM 02 and RLM 63 were de-

37 Above: *Fw 190A-3, WNr 313, of Oblt Arnim Faber of JG 2 at RAF Pembrey on 24 June 1942. The RAF examination report of "dark and light olive green" suggests that the camouflage was 71/02/65 with a yellow rudder and lower engine cowling. Balkenkreuz and the swastika have a thin black border, as do the single chevron and the narrow white fuselage band. Note the unit cockerel emblem*

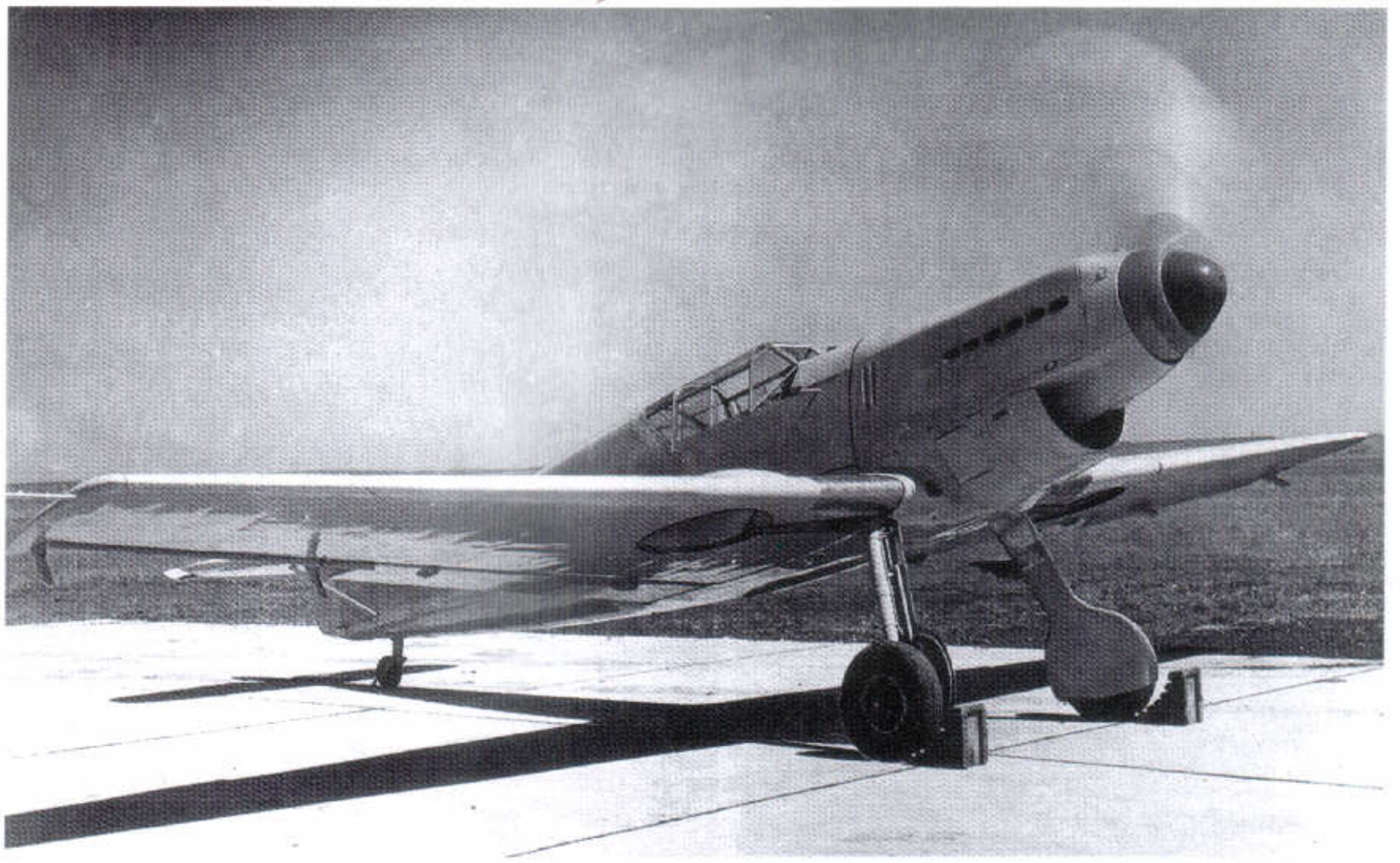
38 Above: *An immaculate Heinkel He 51, finished in L40/52 light grey. Note the high gloss on the wing*

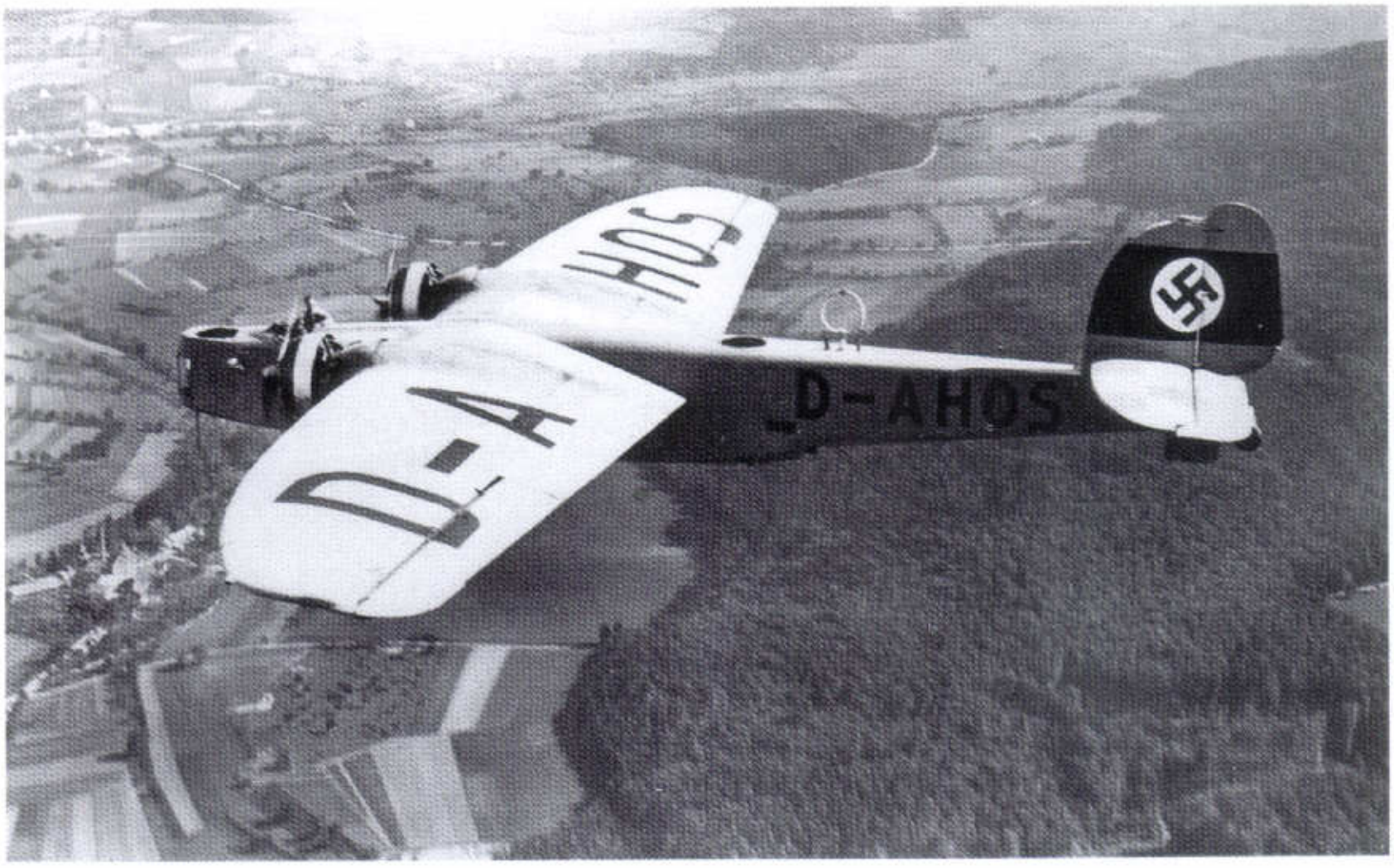
39 Above right: *Taken at the same time as the previous picture, this Heinkel He 51A of I./JG 132, probably at Döberitz in summer 1935, is also finished in the very pale grey. Note the varying finishes to the propeller*

40 Right: *This lineup of He 51As of JG 132, also at Döberitz in 1935, wears the early Luftwaffe markings of a civil registration and the black/white/red starboard rudder bands which were soon superseded by the swastika*

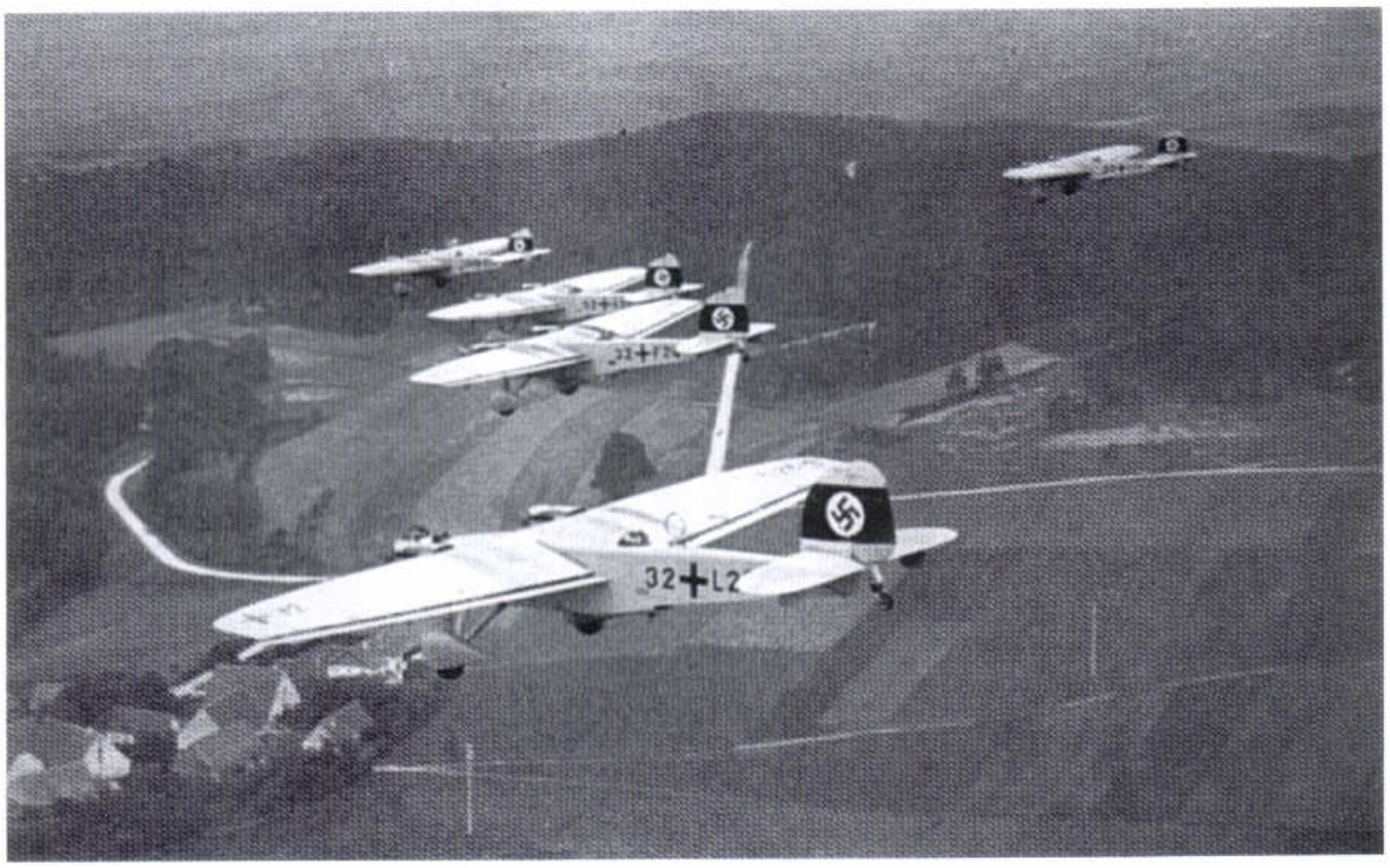


41: *This is the very first Messerschmitt Bf 109, the V-1, WNr 758, at Augsburg in August-September 1935. The registration D-IABI has not been applied yet as the aircraft is still in a mixture of various shades of natural metal and grey-painted panels. This was the only aircraft of the type to be fitted with a Rolls-Royce Kestrel engine*



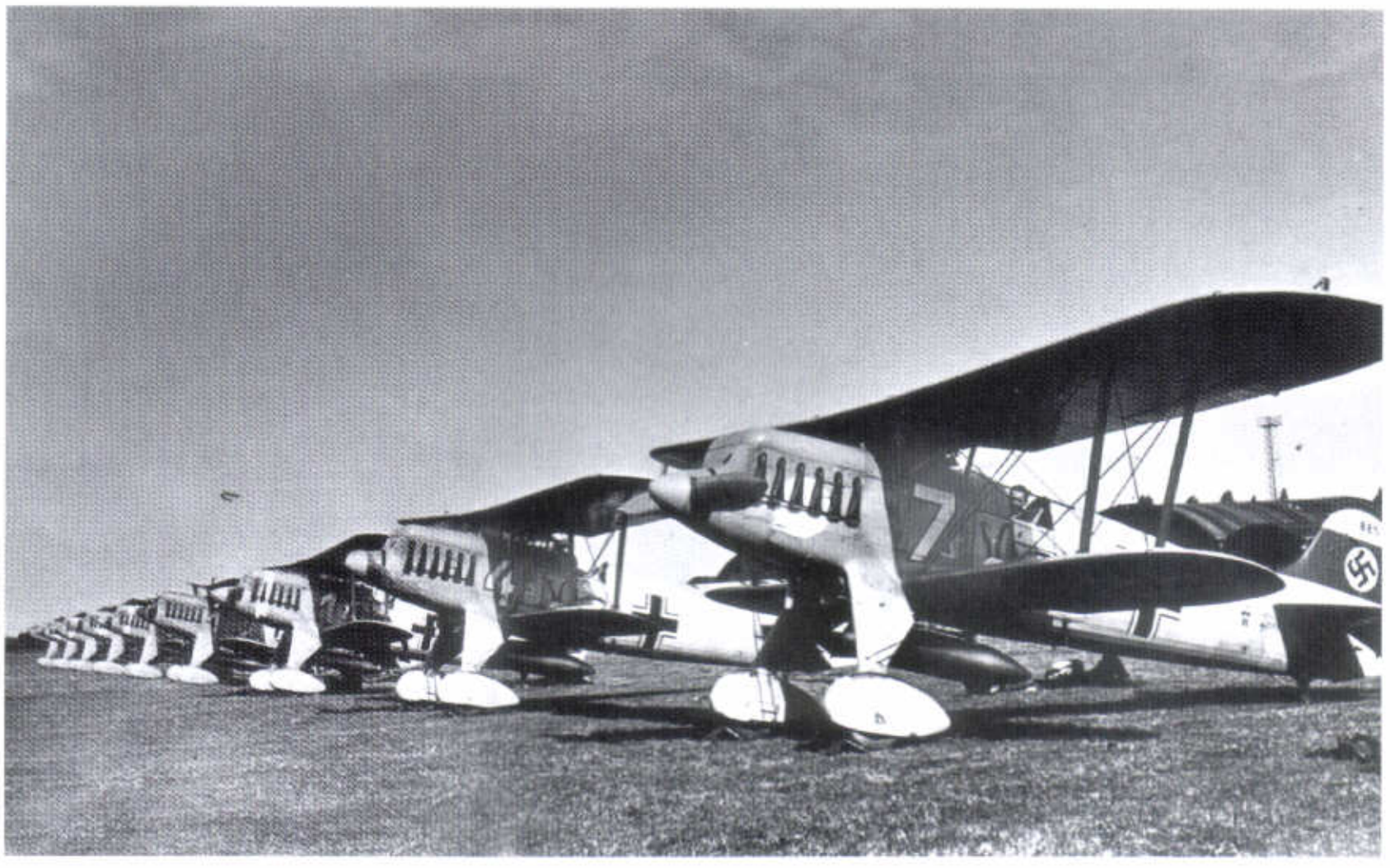


42: *A Dornier Do 11D, D-AHOS, in light grey L40/52 with a Class C civil registration in accordance with the regulations shown on page 146 and a pre-war style swastika in the middle of the fin as shown on page 147*

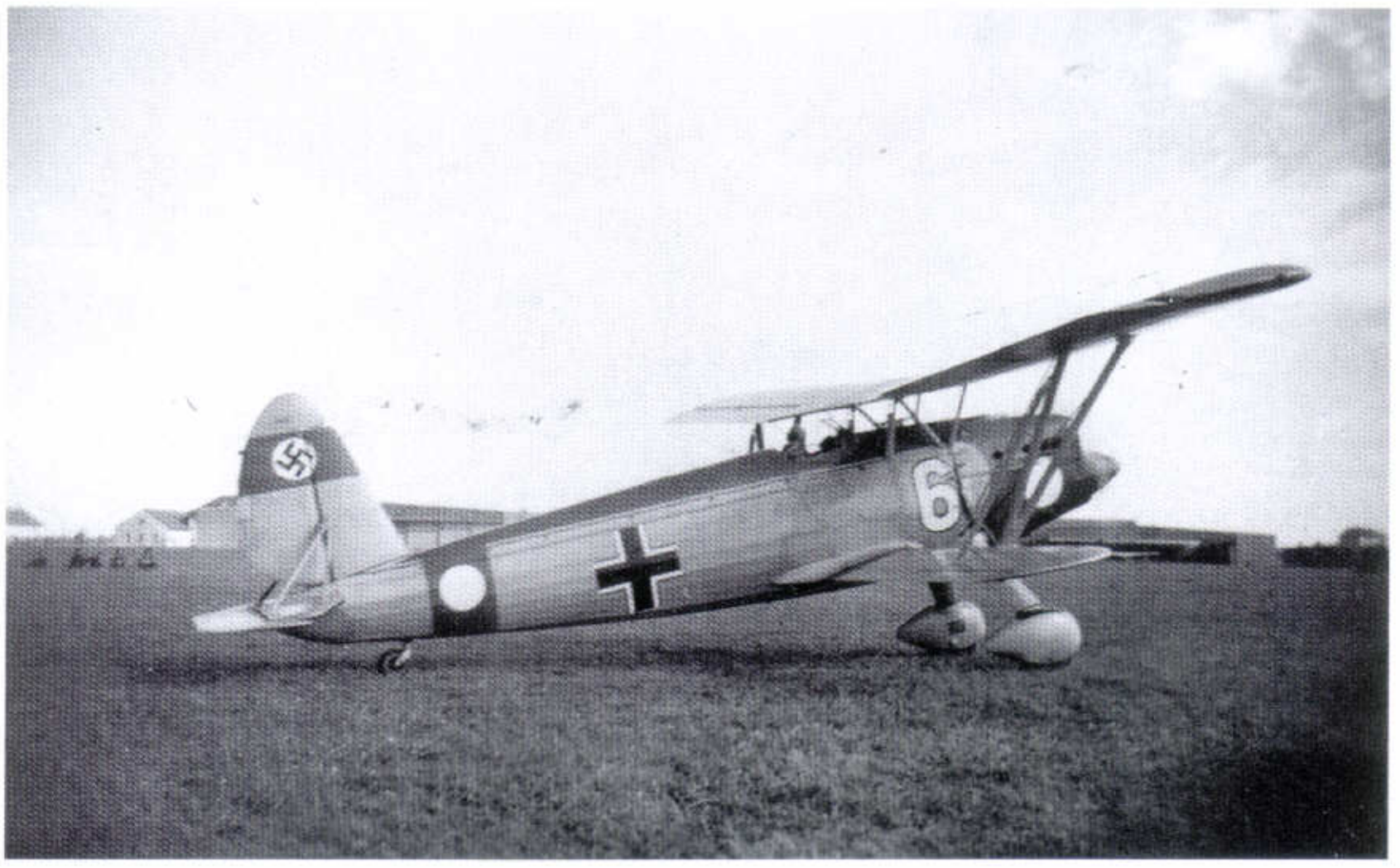


43: *This picture can be easily dated since it comes from* Dornier Post *No. 7 October/ November 1936 and shows "a squadron of Do 23 aircraft on their way to Nuremberg," (where the 1936 Nazi Party Convention took place) to take part in the Wehrmacht's show of strength. The aircraft are covered all over with L 40/ 52 or Avionorm–Nitro paint 7375 matt grey in accordance with the OS list. Despite the fact that the picture is in black and white, a comparison with the black on the Balkenkreuze and the white circle around the swastika shows how light the grey paint is*

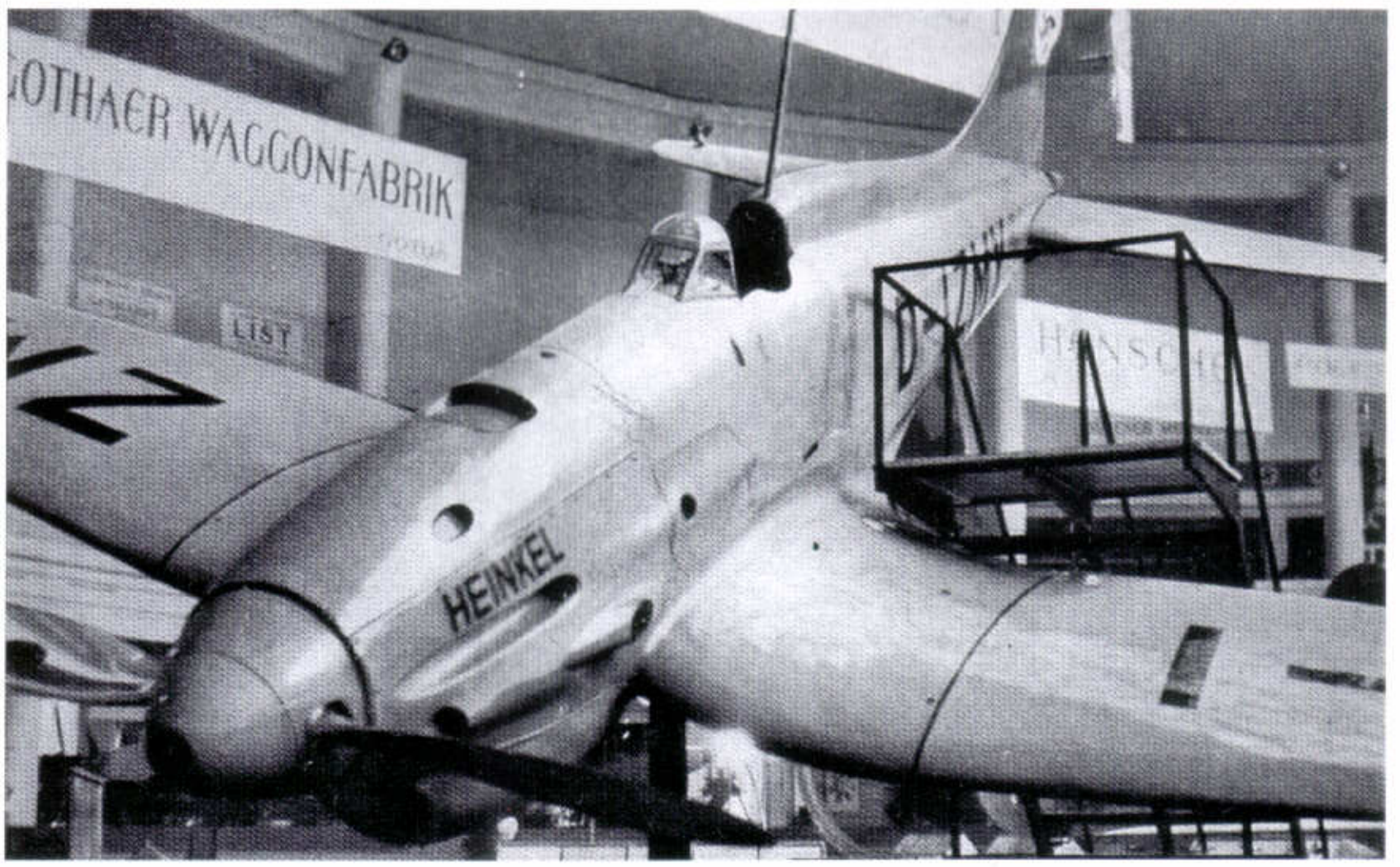
44: *Immaculate silver-doped Heinkel He 45 machines of the reconnaissance school at Kassel wearing military markings as laid down in the instructions on page 147, probably sometime in 1936 as the aircraft all look very clean and new. '40+C11' signifies aircraft 'C' of the 1st staffel of the 1st gruppe of a unit within Luftkreis 4. '0' signifies that there were too few component units to form a complete geschwader. Note the narrow Balkenkreuz on the fuselage*



45: *He 51B fighters of I/JG 233 in 1937. The combination of markings and the sky blue nose and tail bands on the light grey L40/52 finish show that they are from all three staffeln. White '7', Werk Nr 885, of the third staffel not only wears the mountain goat emblem of the unit, but also one of the earliest examples of personal artwork in the Luftwaffe, just forward of the tail. On the original print this is clearly a small figure of a Moor wearing a fez, which has been nonsensically identified elsewhere as a cartoon of Hitler—a sure guarantee of a prison term or worse for the artist*



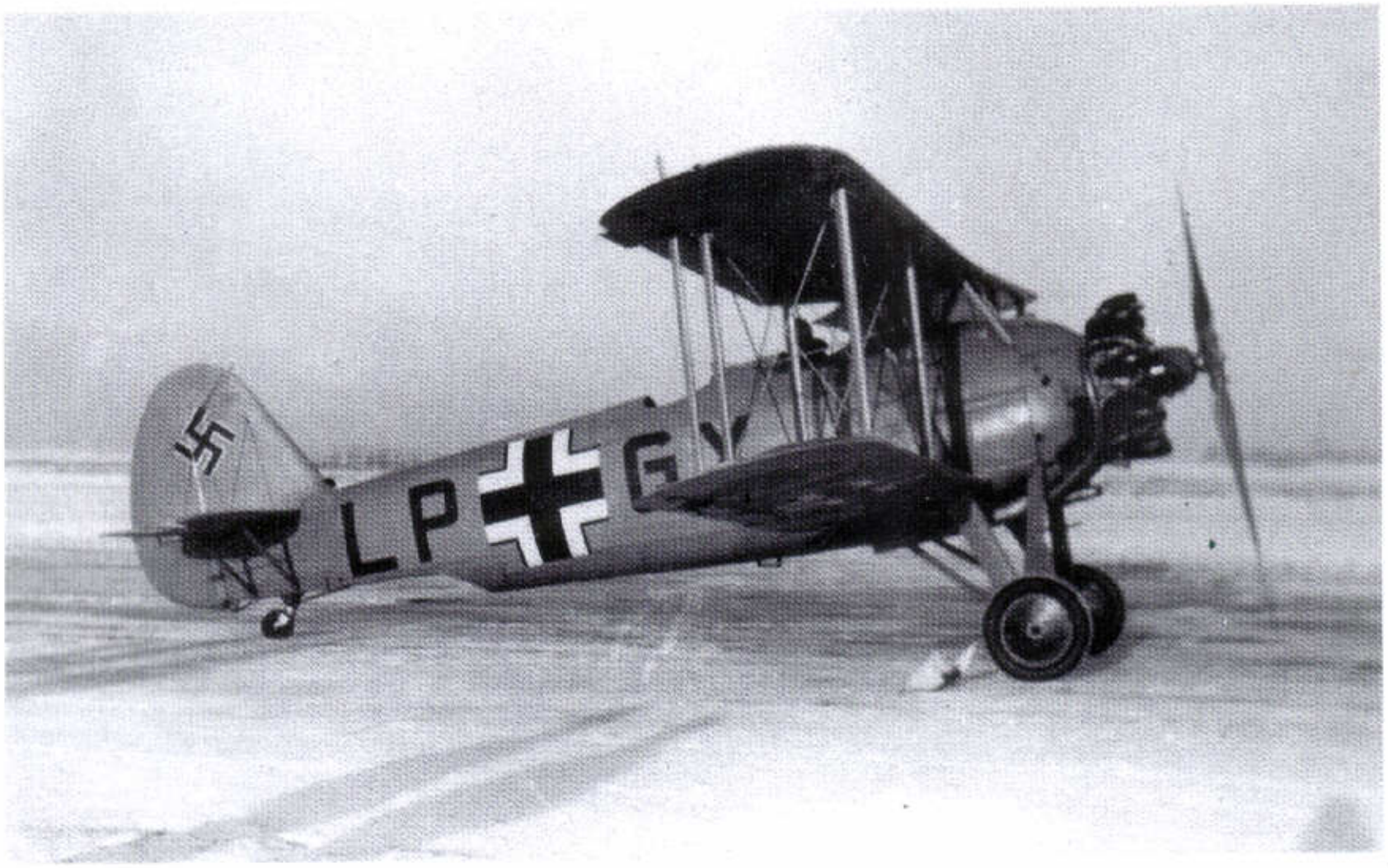
46: *An Arado Ar 68F, 'white 6', of the 3 Staffel of the I Gruppe of JG 134 'Horst Wessel' in typical pre-war paint finish. The surface is very glossy and it is difficult to be certain which paint was used. Compared to the He 51s above the aircraft looks too dark to be in L40/52, consequently it seems most likely that this is an example of the RLM 02 or 63 grey-green paint. All markings have been executed in accordance with pre-war orders. Note the similarity in tone of the brown 'tradition colour' of the Geschwader applied to the fuselage nose and spine in comparison to the red of the tail band*



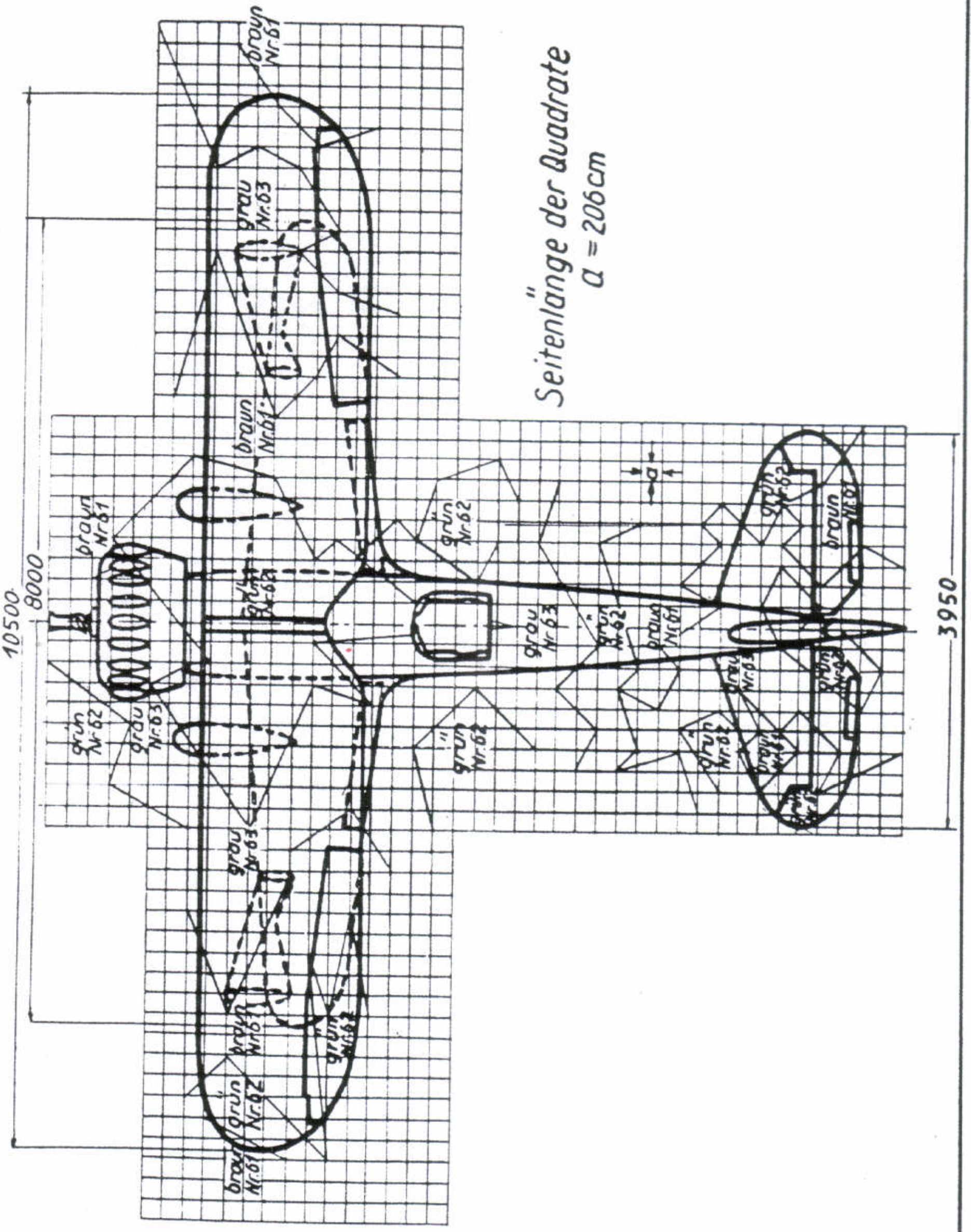
47: *Seen on display in the German section of the International Air Exhibition in Milan in October 1937, this is the Heinkel He 112A-03, D-IZMY. It is finished in the same light grey (probably L40/52) paint scheme in which it had earlier flown at the International Flying Meet in Dübendorf, Switzerland, in July of that year. Note the high-gloss finish and the fact that the red band on the fin does not reach the full width, stopping short of the leading edge. All other markings are in accordance with the regulations of the period. The propeller blades are highly polished aluminium*

48: *This is the Messerschmitt Bf 109V-5 (B-02) in 1936, fitted with a variable-pitch VDM propeller. It was later sent for trials with the Legion Condor in Spain. Here it wears a Class B1 civilian registration, D-IEKS, on what appears to be low contrast camouflage of RLM 70/71, a portion of the pattern of which can be just made out on the nose below and diagonally forward of the air intake. The spinner appears to be light grey or yellow. While the serial number for this aircraft is recorded elsewhere as 879, the legend 'WNr 320' can be made out on top of the fin in the original photo*

49: *Heinkel He 70s of 4.(F)Aufkl.Gr 11, based at Neuhausen in East Prussia (now Gur'evsk in Russia) in about 1937. The nearest machine is in the standard Heinkel factory finish, with the addition of the name of a small East Prussian town (now Olsztynek, Poland) on the gloss black engine cowling. It can be clearly seen that the lightning flash is not white by comparison with the colour of the name but is the same light grey, possibly L40/51 (see page 22) as the rest of the airframe. Another aircraft behind appears to be overall grey. The propeller blades of both are a highly polished silver*



50: *An Heinkel He 50 finished in an overall coat of glossy RLM 02 Grau. LP+GY is in service with an unidentified training school, probably in Czechoslovakia, during the winter of 1939-40. The swastika is in the 'pre-war' position but has been modified by overpainting, lacking the thin black border and has an incomplete white border. There is a barely legible werk nummer on the fin, possibly 1451. Note the black wheel discs*



Sichtschutzschema „B"

51: *Taken from the official handbook, this is the three-tone camouflage pattern 'B' for the Henschel Hs 123*

scribed as identical shades. DKH grey L40/52 or Avionorm Nitro-paint 7375 matt grey were also described as RLM 63 Hellgrau. In my earlier work I designated these two colours as RLM 63a through lack of documentary evidence, in order to mark the difference from the true RLM 63. It can now be stated:

RLM 02 and RLM 63 were two different shades.

RLM 02 was identified as RAL 7003 in the Paint Companies Handbook of 1944, and RLM 63 as RAL 7004 (old). Both RLM colours are very similar but nonetheless different. RLM 02 and 63 have the same colour shade except that RLM 63 is somewhat lighter than RLM 02. A very good reproduction of RAL 7004 (old) is the present RAL 7033. It is a very good match with RLM 63.

To the confusion of everyone, because of the absence of documentation, DKH L40/52 grey (or Avionorm nitro-paint 7375 matt grey) was designated RLM 63 light grey. Aircraft painted in L 40/52 (or Avionorm nitro-paint 7375 matt grey) were in service at the same time as aircraft whose OS lists stated that they were painted in RLM 02. As the clearly evident differences could not be explained, the two shades were designated RLM 63, based on a wrong interpretation of the OS list for the He 52, in the absence of further information. Dated photos show that the light grey paints L 40/52 (or Avionorm 7375 matt grey) were widely used in 1935 but the number of RLM 02 paints rose steadily thereafter, in accordance with L.Dv 521/1, until the light grey paints had disappeared. After the remainders of L 40/52 (or Avionorm 7375 matt grey) had been used up and until the next basic overhaul of the exterior paintwork was due, aircraft painted in this way retained their light grey colour. The front-line machines were then painted in the regulation two-tone (70/71) or three-tone (61/62/63) colours. This explains the initially high proportion of light grey aircraft which then were consistently reduced until they had quite disappeared (from combat units at least) by 1939.

Enthusiasts are generally unaware that while RLM numbered shades certainly existed before the 1938 edition of the L.Dv 521/1, aircraft paints were also standardised within the RLM only when the 1938 edition appeared. The aviation lacquer groups were no longer coded with manufacturer's data but aircraft material numbers were now allocated (e.g. 7115.02 or 7136.70; the last two digits designating the shade under the RLM, i.e. in this case Grau 02 or Schwarzgrün 70).

The 1937 to 1939 period also includes the formation and engagement of the Legion Condor in the Spanish Civil War. Aircraft used then retained their standard colours as described above. In Spain itself, a protective coating in RLM 61 (Dunkelbrun) and/or RLM 62 (Grün) or also of the paints available in Spain was applied as an expedient to surfaces uniformly treated with L 40/52 or Avionorm Nitro-paint 7375 matt Grau (light grey).

At the end of 1936, the three-tone segmented camouflage was applied to all front-line aircraft in the colours:

RLM 61	Dunkelbraun	Dark brown
RLM 62	Grün	Green
RLM 63	Hellgrau	Light grey
RLM 65	Hellblau	Light blue

One of the variations of the Henschel Hs 123 in these colours is shown on page 43, while two variants of the camouflage pattern of the Do 17E appear on pages 48 and 49. When comparing the drawings, it is evident that colours were substituted while the camouflage design remained identical.

By the time that the draft L.Dv 521/1 was issued in 1938, the operational doctrine of the Luftwaffe had been established, namely to support the Army in action, acting as a kind of 'flying artillery'. This goes some way towards explaining the absence of long-range fighters and bombers in later years. The Luftwaffe was to operate together with the Army. What need was there for strategic long-range bombers with fighter support?

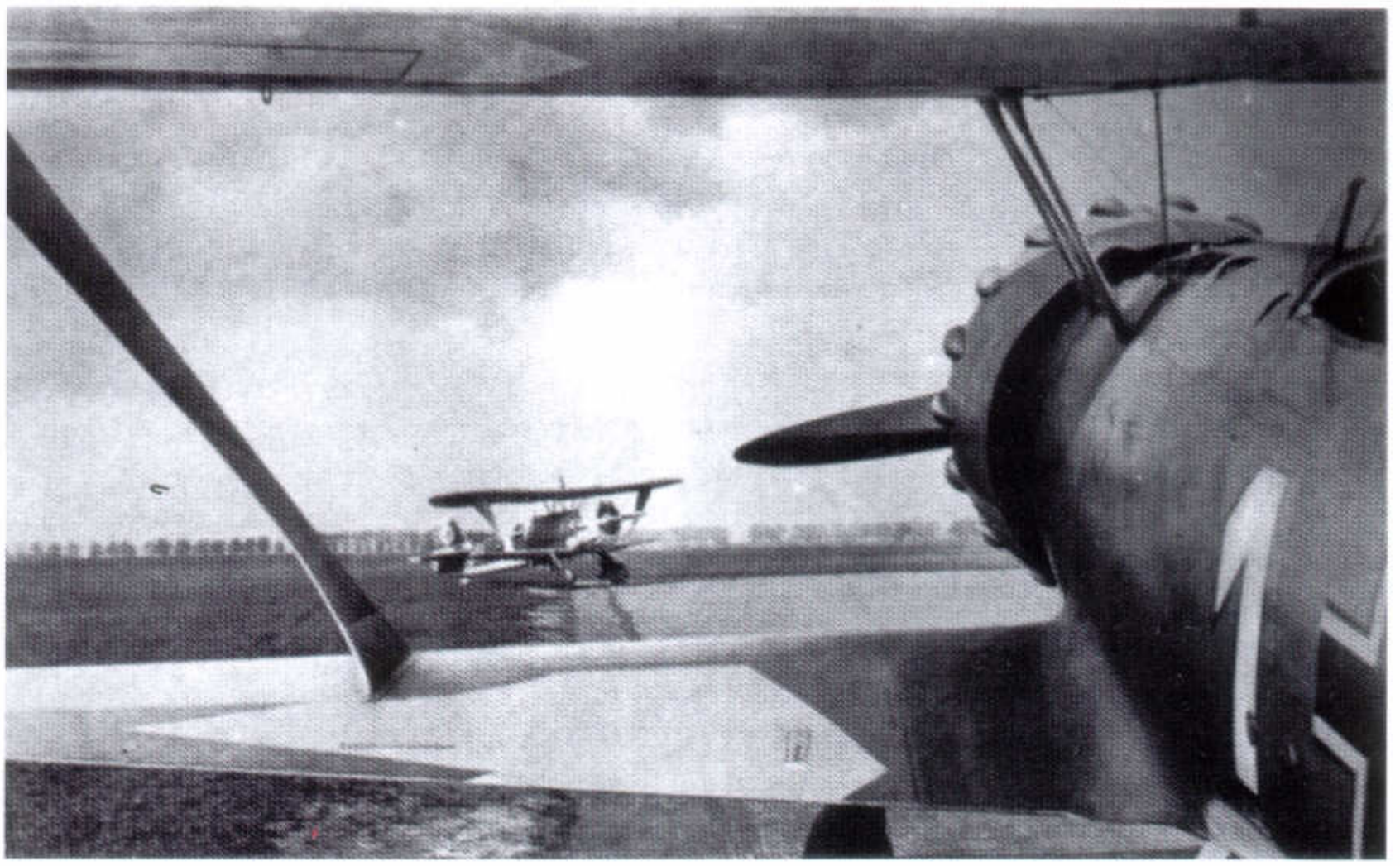
Whether it was this crystallisation of doctrine, experience in Spain or simply the cost in money and man-hours that led to a re-assessment of the complex three-tone uppersurface patterns, it is a fact that with the draft L.Dv 521/1, new colours were also introduced, adapted to the new role. The standard camouflage for all operational aircraft (except those with the navy) after 1938 was to be:

RLM 70	Schwarzgrün	Black-green
RLM 71	Dunkelgrün	Dark green
RLM 65	Hellblau	Light blue

The manufacturer was to paint all newly built aircraft with this standard camouflage, those already in service were to be painted by the units concerned if they were able to do so. This is the reason why so many aircraft that took part in the Polish campaign were still painted in the old camouflage (RLM 61, 62 and 63). The old camouflage even reappeared in Russia in early 1943 when night attack squadrons were being formed, equipped with old and obsolete aircraft.

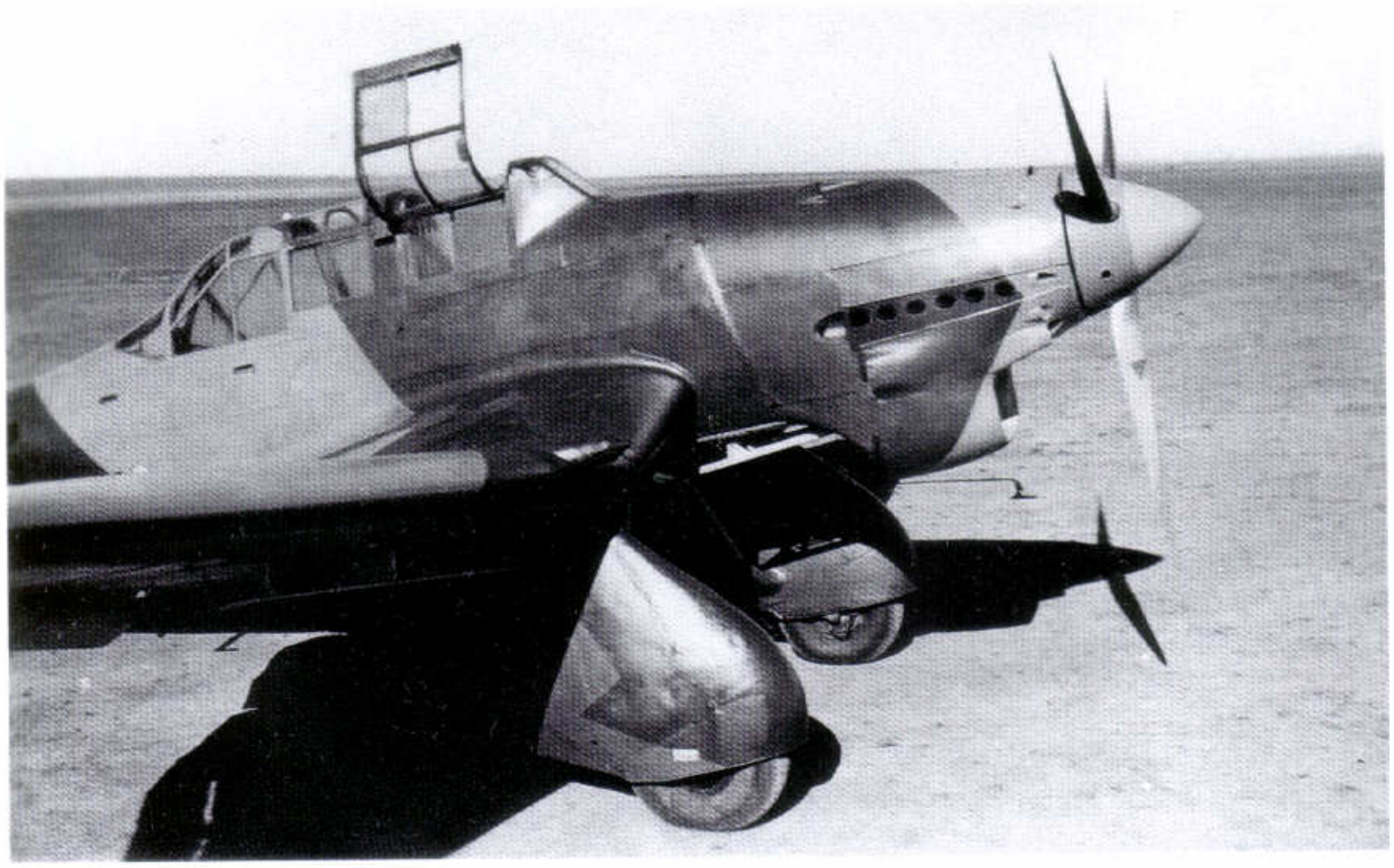
Experience from the Polish campaign influenced camouflage. It had shown that air superiority was essential in the field of battle. Air superiority enabled bombers, dive-bombers and fighters to fulfil their potential undisturbed by enemy aircraft over the battlefield. This doctrine is still valid, as the Second Gulf War in 1991 showed. Air superiority was to be obtained with the Bf 109 fighter. The Bf 110 destroyer was to accompany the bombers in flight, since the Bf 109's range was far too short for this purpose.

52: *This view shows the port wing of an Hs 123 in pre-war markings and the three-tone 61/62/63 camouflage pattern 'A'. The white '1' has a narrow black outline and the Balkenkreuz is of the narrow type first used in 1935 with an additional thin black line outline to the white portions introduced shortly afterwards*

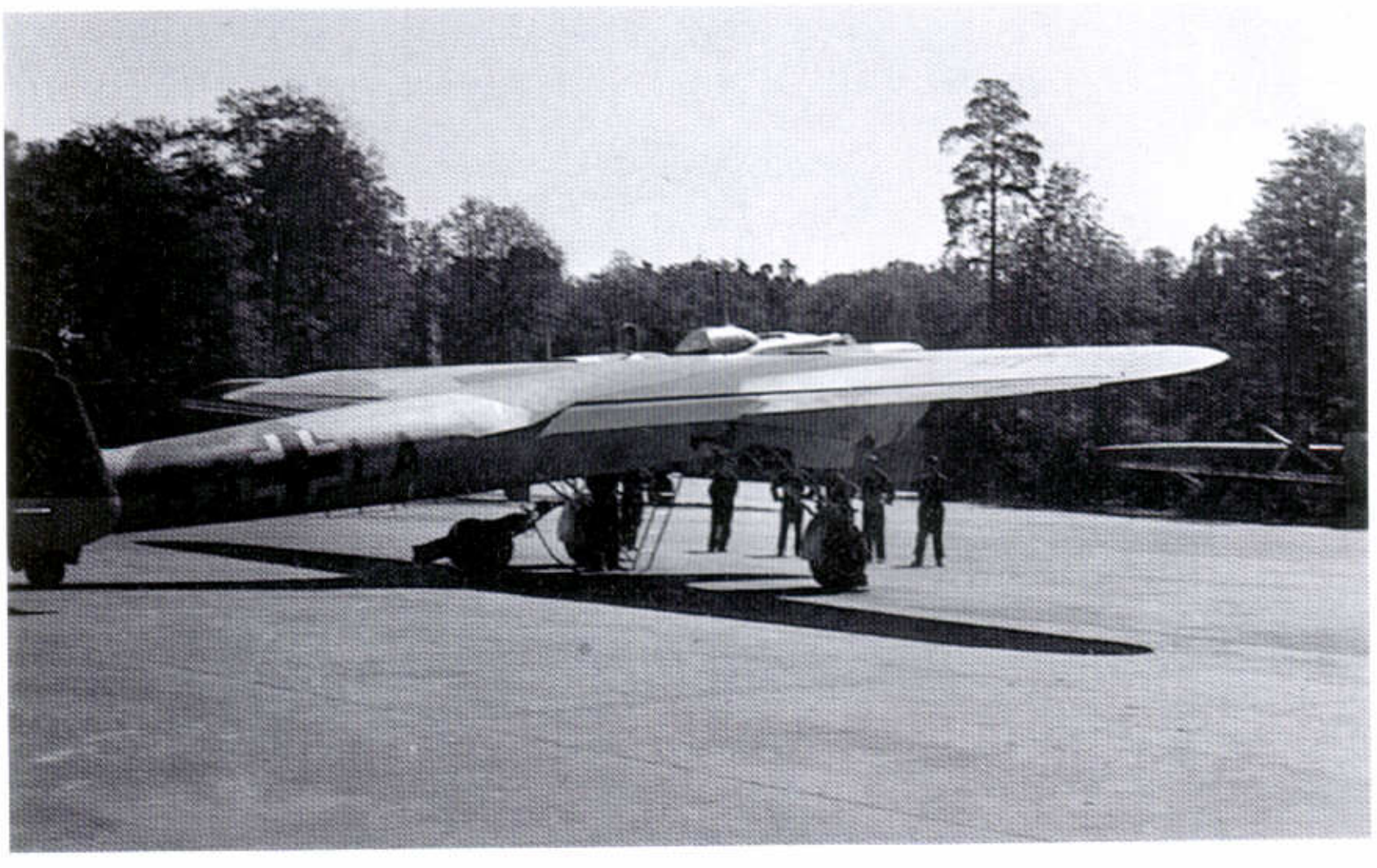


53: *An elderly Henschel Hs 123, BQ+NL, werk nummer 2729, seen in service in winter 1940 with an unidentified Luftwaffe training school, probably somewhere in Czechoslovakia. It retains the 61/62/63/65 camouflage with an 'early-war' style fuselage Balkenkreuz with thin black border. The swastika remains in the middle of the fin*

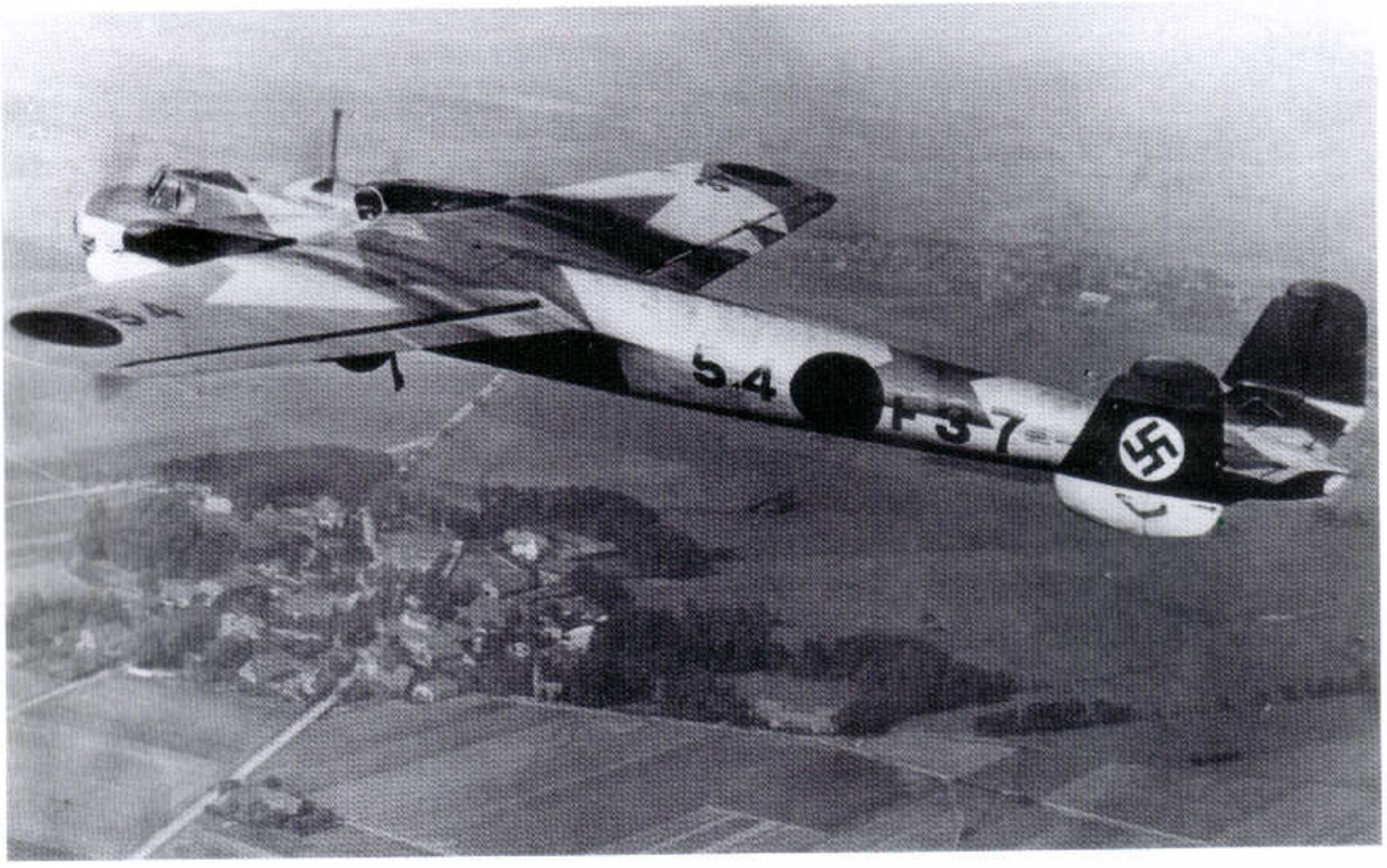
54: *Dornier Do 17P or Z bombers in production. It can be seen that the fuselages are already finished in camouflage with the Balkenkreuz applied before they are mated to the wings and tailplane assemblies. These are in RLM 02 and two machines at least already have the national markings applied. Just visible in the background are two aircraft with the swastika applied to the fin on a red band*



55: *This Junkers Ju 87A-1 was the third example to be used on trials in Spain. Coded 29-3, it is finished in the 61/62/63 camouflage and is apparently brand new. The glossy finish to the paint is noteworthy*



56: *A Dornier Do 17E, BD+LA, in the pre-war 61/62/63/65 camouflage. Compared with the official drawing on page 49 it appears to wear the 'B' scheme. Of interest is the 'pre-war' style of wing cross with narrow white sections, while that on the fuselage is the 'early' war style with thick white angles and a thin black outline. The code suggests that it is in service with a training school*



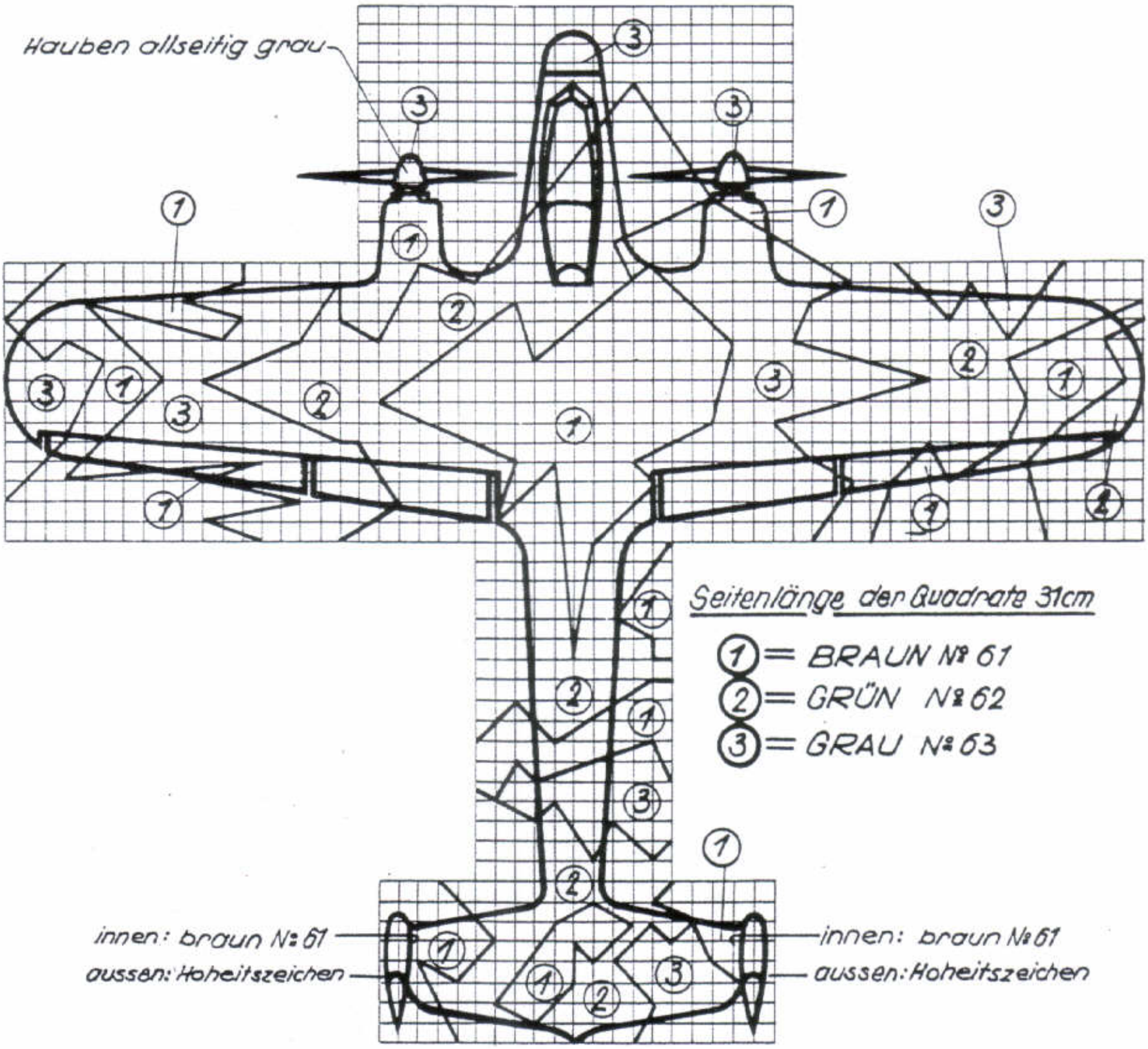
57: *This Dornier Do 17E, 'F', of 7./KG 255 (the 'Alpen geschwader') during war games in 1938. It is finished in the classic three-colour 61/62/63 camouflage in pattern 'A' (see page 48) with all the Balkenkreuze obscured by washable black paint for the purposes of the exercise. The style and placement of all the markings are in strict accordance with prevailing instructions*

58: *A Dornier Do 17E of the Geschwader Stab of KG 51 wearing RLM 61/62/63/65 camouflage. Although the aircraft retains the pre-war 'old' style Balkenkreuz, there is evidence of repainting on the fuselage to accommodate the new letter-number unit codes introduced in early 1939. The propeller tip was painted in RLM 23 Rot or possibly RLM 24 Dunkelblau so as to identify a Geschwader Stab machine*

59: *Junkers Ju 86E-1, SE+PX, of FFS C19 in RLM 61/62/63/65 camouflage (possibly pattern A1a) after crash-landing at Prague-Ruszyne sometime in 1941, long after such camouflage had been replaced on front-line aircraft. The swastika and the Balkenkreuz both have the thin black border*

60: *Junkers Ju 87B-1s of VJ/88 in Spain in 1938. Although not clear in this picture, other photos of 29-8 and sister aircraft reveal that the machines were some of the first to wear the classic RLM 70/71 green camouflage on operations*

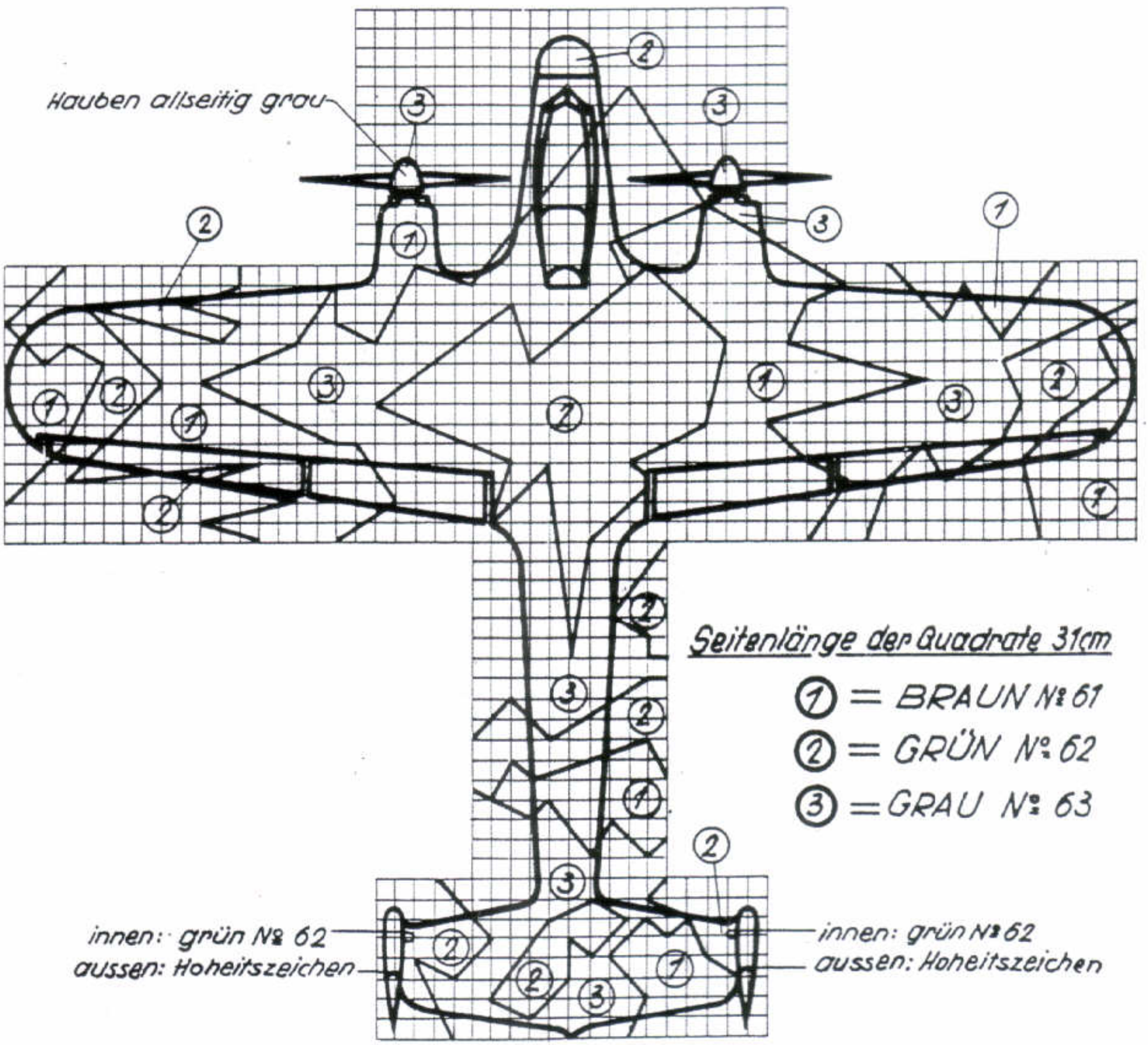
61: *This extract from the official aircraft handbook for the Dornier Do 17E shows the arrangement of the three pre-war camouflage colours RLM 61,62, 63 in Pattern 'A'*



Sichtschutzschaubild 2a

Farbenanordnung A

62: *This extract from the official aircraft handbook for the Dornier Do 17E shows the arrangement of the three pre-war camouflage colours RLM 61,62, 63 in Pattern 'B'*



Sichtschutzschaubild 2a

Farbenanordnung B

The Bf 109's green paint proved unsuitable for engagements in the air. The dark (green) paint made the aircraft stand out against the sky and therefore more easily detected (comparisons with references in the 1941 L.Dv 521/1 Chapter "Converting aircraft from standard night camouflage to standard daytime camouflage and vice versa". See page 00 of this book). The Bf 109's camouflage had to be made much lighter.

Trials with camouflage systems for the Bf 109 and Bf 110 began early in 1940. Initially, the sides of the Bf 109 fuselage (the area generally seen by an opponent approaching in the air) were painted in RLM 65. RLM 70/71 was applied only to around a quarter of the fuselage area. At about the same time, attempts were made to achieve the same result by replacing a green (RLM 70 or 71) with RLM 02. The undersides and sides of the fuselage were retained in RLM 65. There were, therefore, a number of variations of camouflage schemes which were applied to both the Bf 109 and Bf 110:

RLM 02 RLM grau	RLM 02 RLM grau
RLM 70 Schwarzgrün	RLM 71 Dunkelgrün
RLM 65 Hellblau	RLM 65 Hellblau

Cloudy patches of camouflage using RLM 02, 70 or 71, so characteristic of German aircraft, were then also applied to the fuselage sides in addition to these grey-green variants.

In addition to these schemes, camouflage may have also appeared on the Bf 109 with the upper surfaces in a uniform coat of RLM 70 Schwarzgrün or RLM 71 Dunkelgrün. Here also there were variations, with the fuselage sides in RLM 65 Hellblau or uniform with the upper surface colour.

However, these various trials with different camouflage patterns and colours were only a transition towards further attempts to produce the optimum fighter colour.

After the successful Blitzkrieg in the West in early 1940, Britain was the next target. The air battles over the Channel and mainland Britain soon showed that the ideal fighter camouflage had not yet been achieved.

The search for new fighter colours also had its effect on the underside light blue, RLM 65. The RLM 65 shade was modified away from the 1938 tone in 1941. It moved much closer to the new RLM 76 than the old RLM 65, which was clearly more bluish. The possible reason for this change of shade was that the new RLM 65 more easily matched the central European skies than the old, rather darker colour.

Bf 109s shot down over Britain carried many different variations of blue and/or grey shades. These were experimental and test patterns which resulted in a standard camouflage for fighters and destroyers towards summer 1940. This camouflage consisted of the colours:

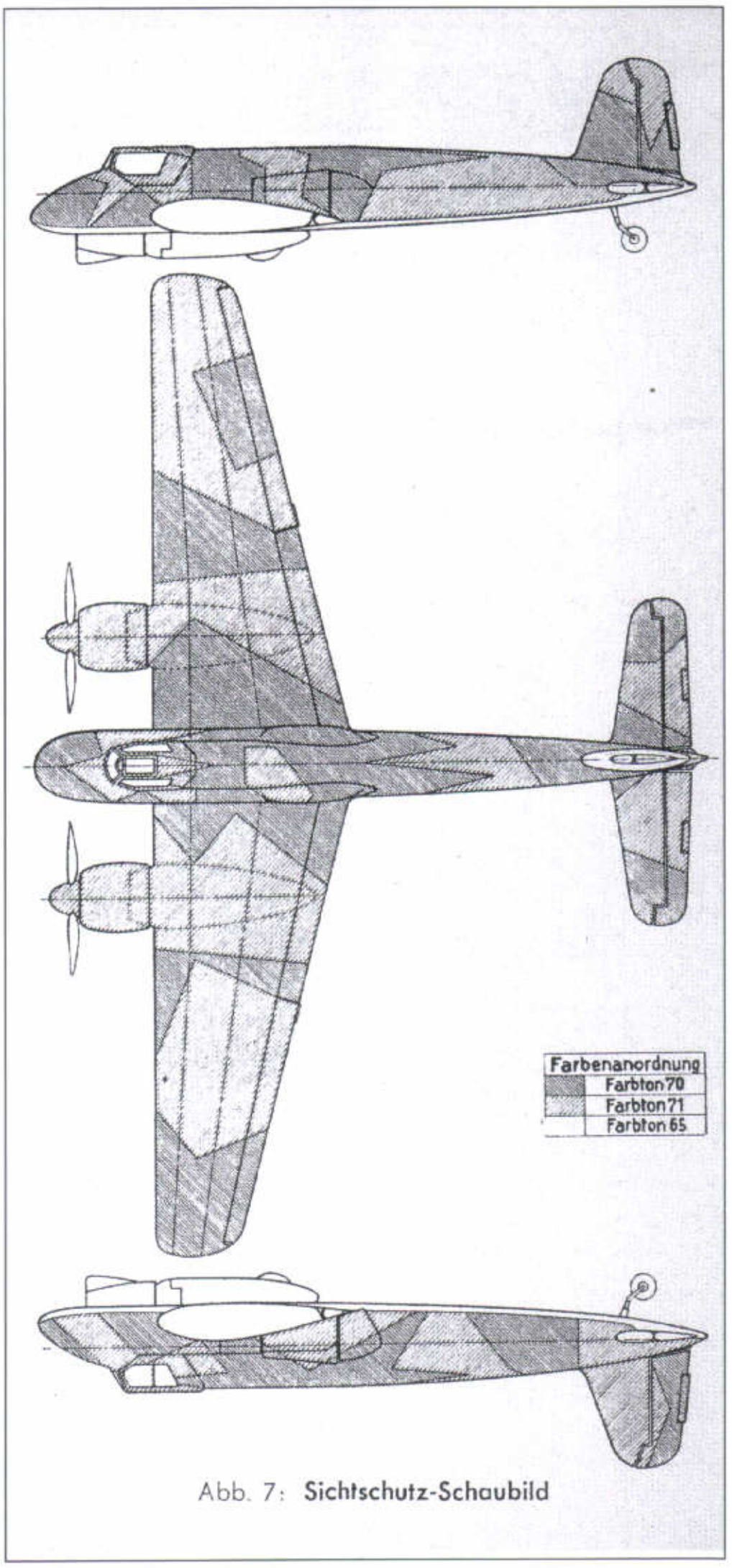


Abb. 7: **Sichtschutz-Schaubild**

RLM 74	Dunkelgrau	Dark grey, greenish
RLM 75	Mittelgrau	Medium grey
RLM 76	Lichtblau	Light blue

The fuselage sides were sprayed with a mottle of RLM 02, 70 and 75. This pattern became the standard finish for fighters and destroyers in the coming years and is what

63 Above: *This extract from Part 0 of the handbook (diagram 7) for the Henschel Hs 129B-1 and B-2, dating from March 1944, shows the official camouflage pattern in RLM 70/71/65 as it was intended to be applied to the aircraft. It is typical of the information used by painters at unit level*

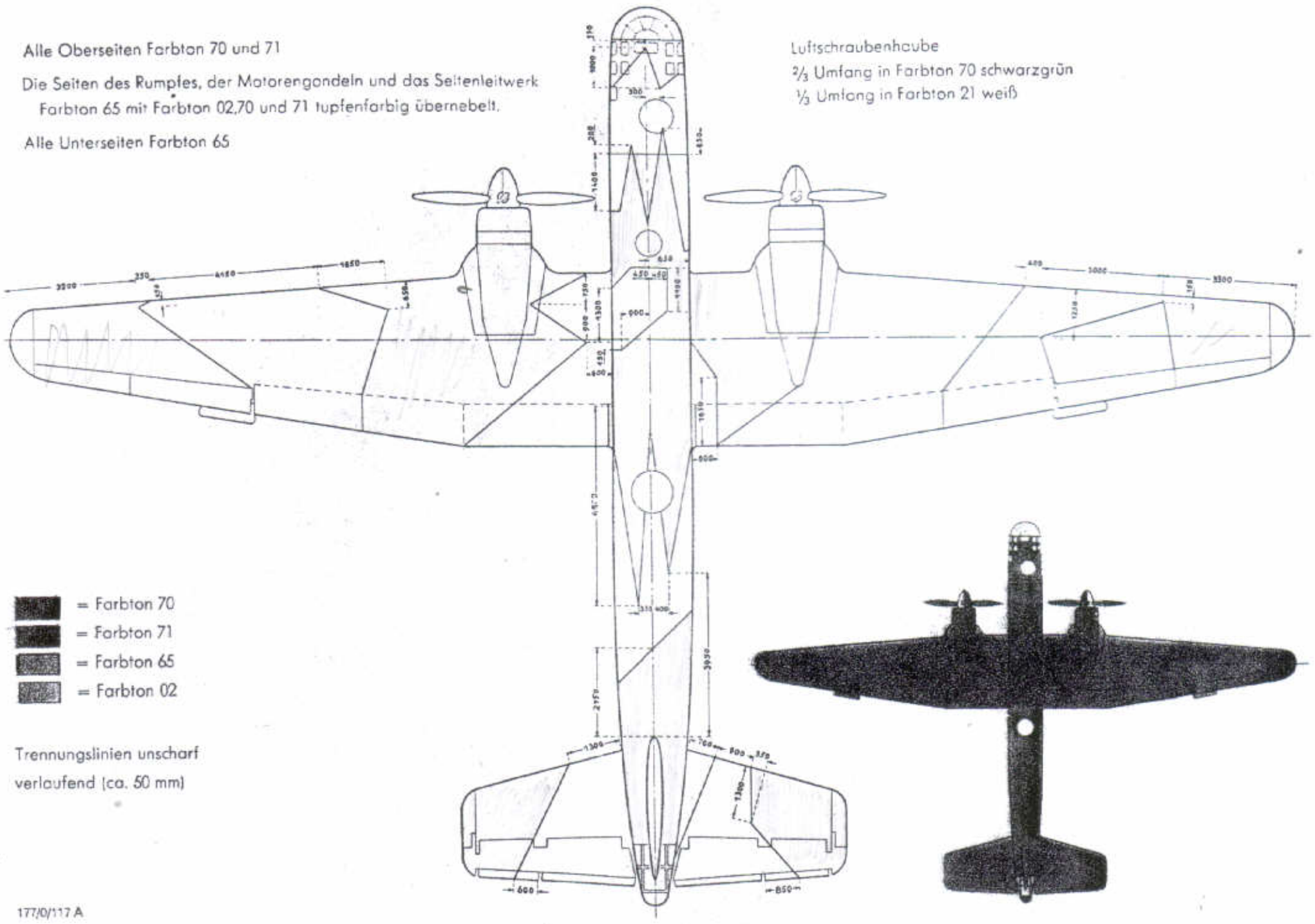

Alle Oberseiten Farbton 70 und 71
Die Seiten des Rumpfes, der Motorengondeln und das Seitenleitwerk Farbton 65 mit Farbton 02,70 und 71 tupfenfarbig übernebelt.
Alle Unterseiten Farbton 65
Luftschraubenhaube
2/3 Umfang in Farbton 70 schwarzgrün
1/3 Umfang in Farbton 21 weiß
= Farbton 70
= Farbton 71
= Farbton 65
= Farbton 02
Trennungslinien unscharf verlaufend (ca. 50 mm)
177/0/117 A

Abb. 28: Vierfarbensichtschutz (Draufsicht)

could be called an 'air superiority camouflage'. All other operational Luftwaffe aircraft (except for night fighters, desert and naval aircraft) retained the RLM 70, 71 and 65 colours introduced in 1938 for the next few years.

New camouflage colours were introduced for Luftwaffe aircraft around mid-1944:

RLM 81	Braunviolett	Brown-violet
RLM 82	Hellgrün	Light green
RLM 83	Dunkelgrün	Dark green

Variations of RLM 76 were also used, attributable to a shortage of raw materials, resulting in a light grey-green or light grey blue.

There seem to have been two reasons for introducing these colours. Firstly, to save on raw materials important for the war effort; secondly, because of the change of operational policy to that of defending German airspace. In other words, in view of Allied air superiority, the Luftwaffe had been forced into a defensive, instead of offensive, posture.

Towards the end of the war, these colours replaced all RLM shades used up till then for camouflaging aircraft. There is no other explanation for the massive spread and use of these colours just a few months before the war ended on all aircraft flown by the Luftwaffe, whether they were new or already operational.

The newly introduced shades were used in the most varied combinations with each other and processed with residual stocks of the 'old' colours, so that a large number of camouflage schemes were in use. They were prescribed in the RLM's *Sammelmitteilung* — Collective Announcement—1 of July 1944:

"The introduction of these colours is now established as follows:

1) Shades 81 and 82 will be used on new types of aircraft on which shades 70 and 71 were hitherto used in line with their operational purpose.

64 Above: *This extract from Part 0 of the handbook (diagram 28) for the Heinkel He 177A-3 shows the official camouflage pattern in RLM 70/71 as applied to the uppersurfaces of the aircraft. The fuselage sides and fin and rudder were to be mottled in 70,71 and 02. A colour side view showing the intended effect can be found on page 137 of this book*

2) Shades 81 and 82 will replace shades 70 and 71 for the current series at the next possible opportunity. Existing quantities of 70 and 71 will of course be used up. Since it must be assumed that the two shades cannot be equally used up and to avoid re-ordering of smaller quantities of 70 or 71, the residual quantities can be used up in the following combinations:

Shade 70 (residual quantity) + shade 82
Shade 71 (residual quantity) + shade 81

Should the residual quantity of a shade be simply too large and the transitional period up to regulation camouflage become too long, an attempt must be made to exchange these quantities with sub-suppliers, group factories or other aircraft establishments."

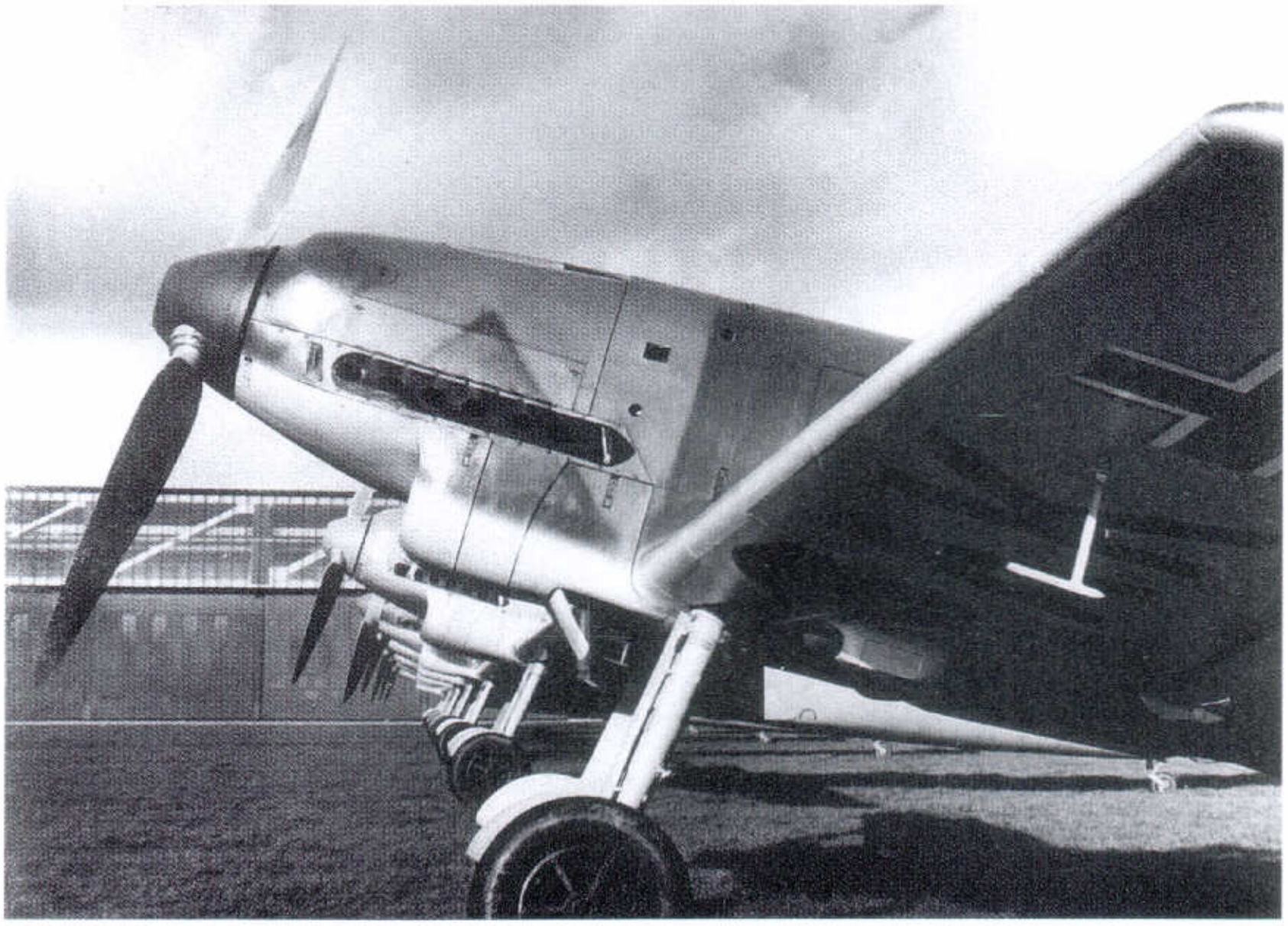
An overview as to what variation was used where is attempted in the table below, which shows only the main camouflage colours. Colours used for reproducing shadows on the fuselage sides i.e. mottling, are not listed.

Up till now, certain duties of Luftwaffe aircraft have been left out of this account so as not to confuse the chronological arrangement. These will be dealt with in greater detail in the following chapters.

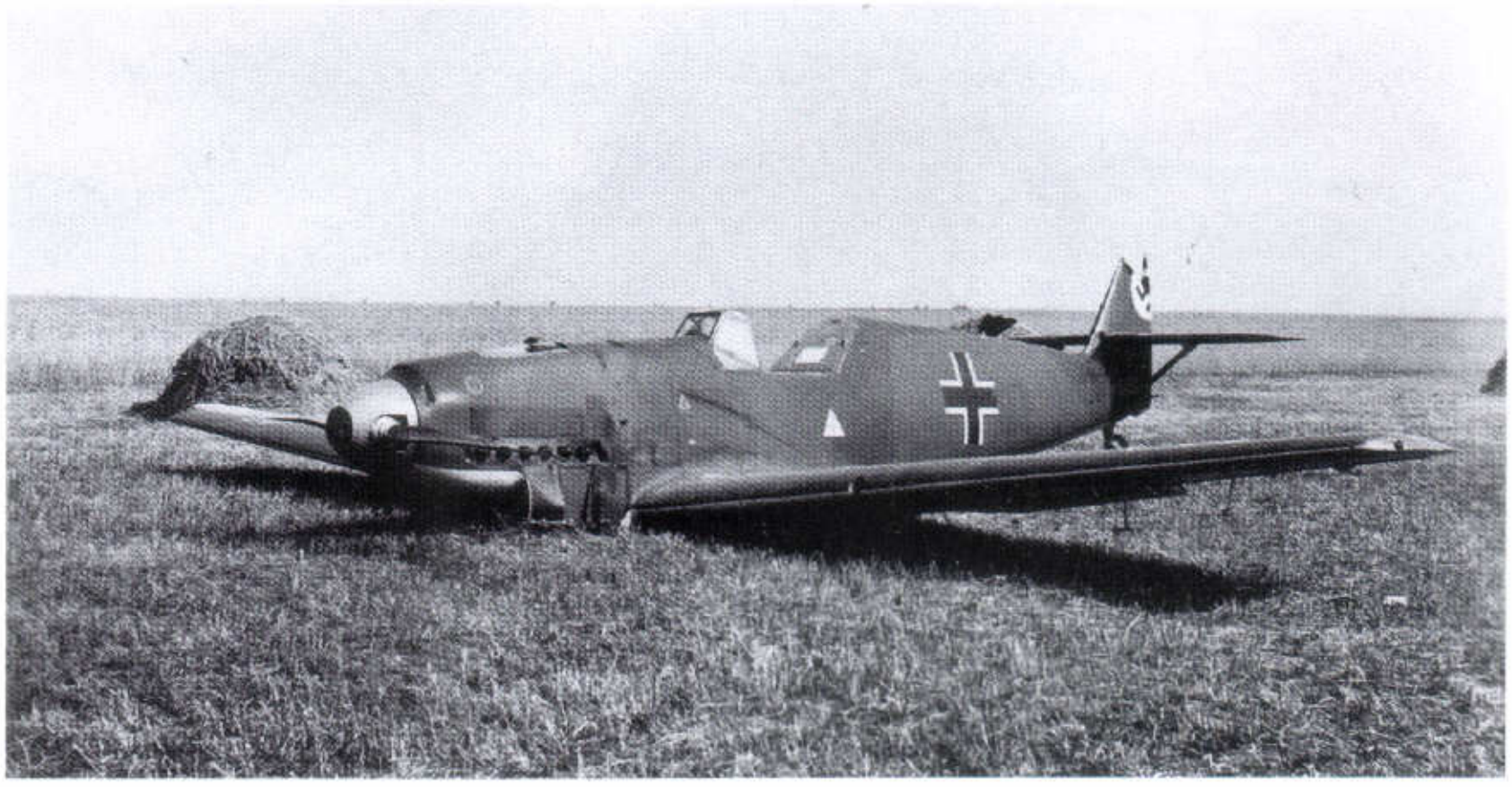
Upper surface	Underside	Used on
RLM 83 dark green RLM 75 medium grey	RLM 76 light grey	Bf 109, Fw 190
RLM 81 brown violet RLM 82 light green	RLM 76 light grey	Me 262, Fw 190, Do 335, He 111
RLM 76 light grey RLM 83 dark green + RLM 82 light green	RLM 76 light grey	Night fighters

65 Below: *Uffz. Otto Polenz's Bf 109B-1 in a worn overall coat of L40/52 light grey, relieved only by black around the exhausts. Shown here in December 1937 after nine month's service in Spain*

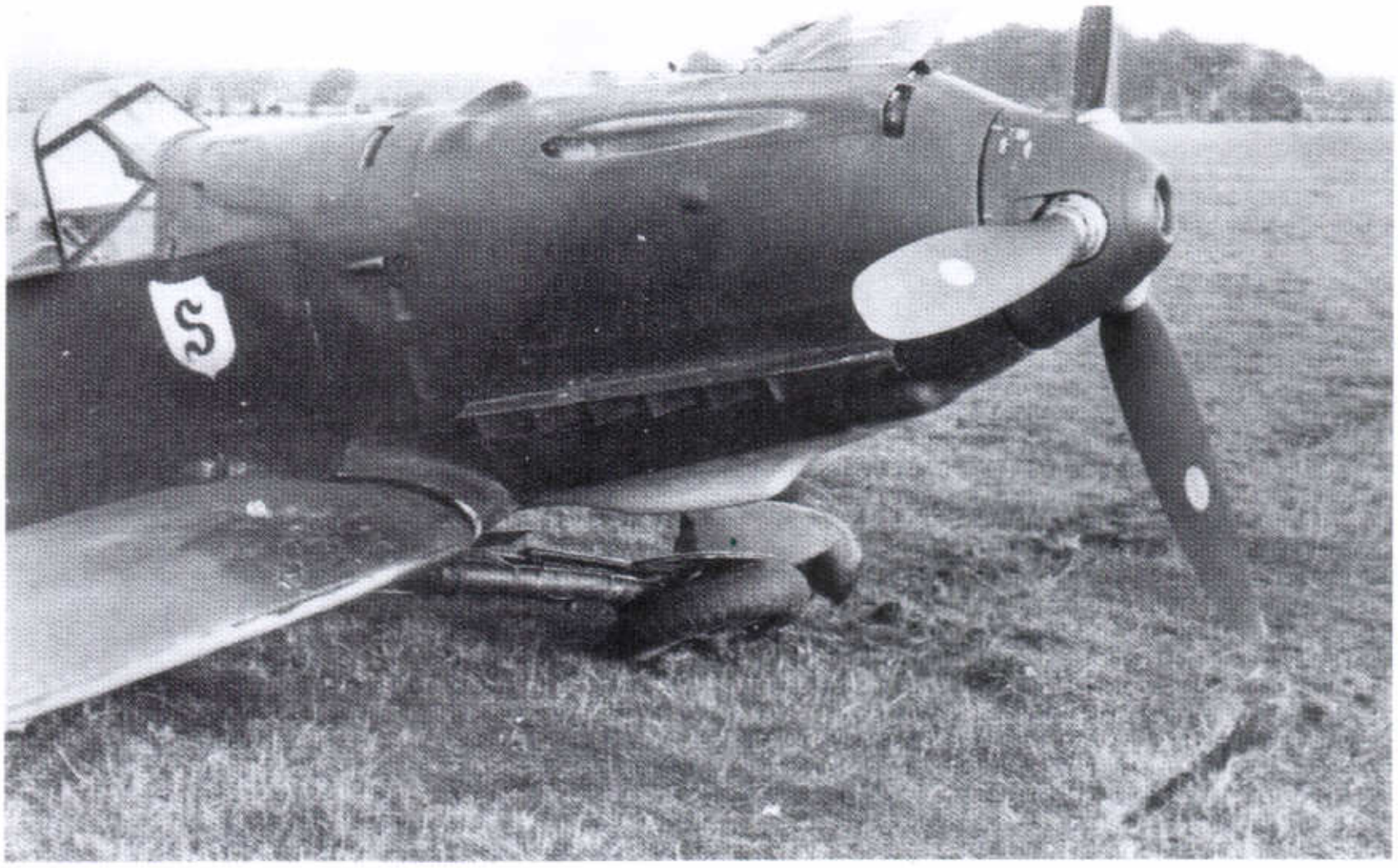
66 Right: *This is the last BFW-built Messerschmitt Bf 109B, WNr 1719, on 16 November 1937 outside the factory at Augsburg. It is clearly finished in the new RLM 70/71/65 camouflage colours, with the early narrow style of Balkenkreuze. The spinner on the VDM propeller is finished in RLM 70. Note that the remaining aircraft in the lineup all appear to be overall light grey*



67: *A crashlanded Messerschmitt Bf 109C-1 or D-1. The lack of any unit markings suggests that it may have been on a delivery or test flight. The narrow style crosses and dark RLM 70/71 finish are classic examples of the marking and camouflage regulations of the time. A very dull looking machine, only enlivened by what may be a yellow propeller spinner. Date probably about autumn 1938*

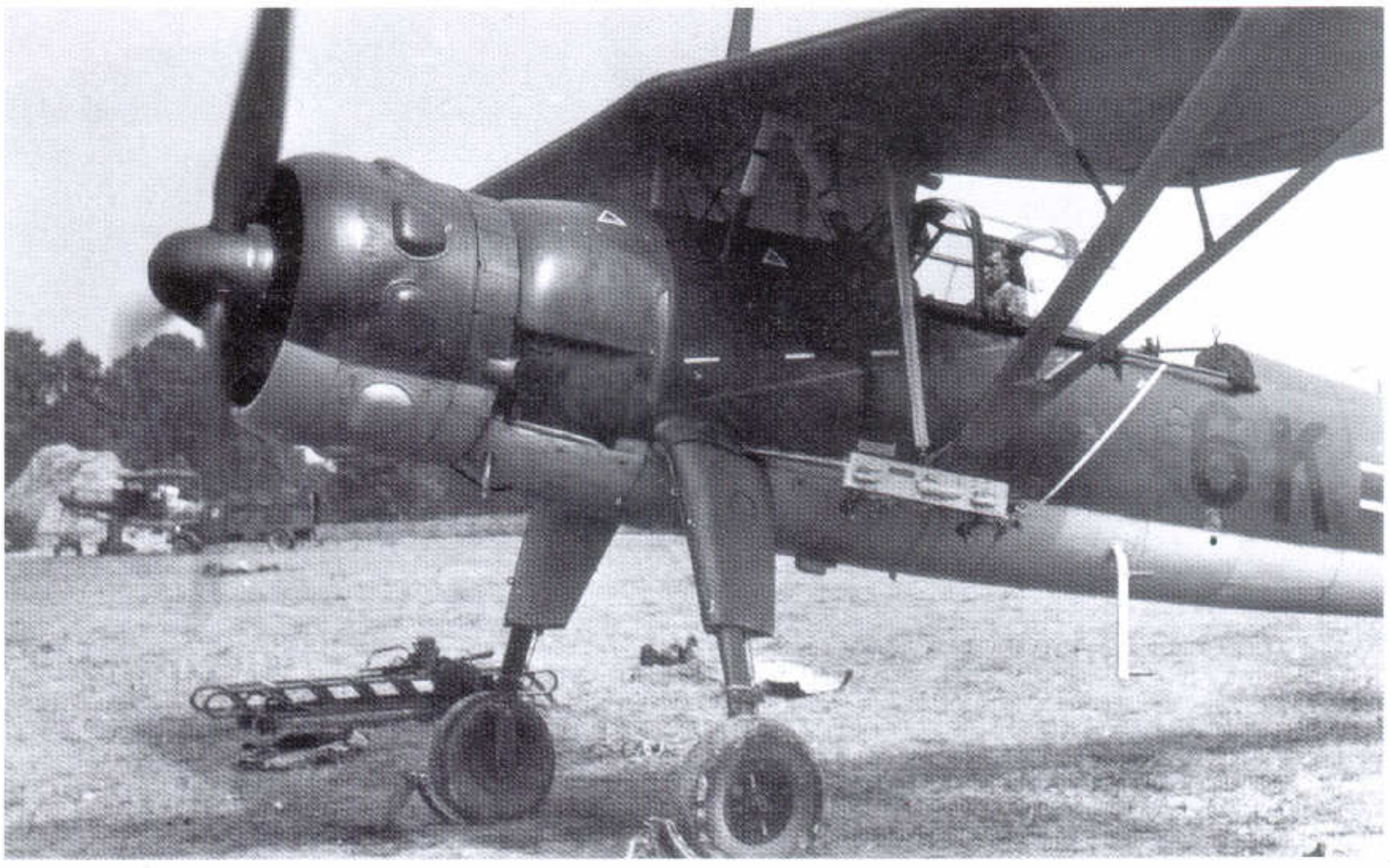


68: *An early E-model Bf 109 of JG 26 in a 70/71/65 scheme after a typical landing accident caused by the type's narrow track undercarriage. It is clear that the spinner and the propeller-blades were painted in RLM 70 in accordance with the regulations (see page 247). Note the very low tonal contrast between the two greens*



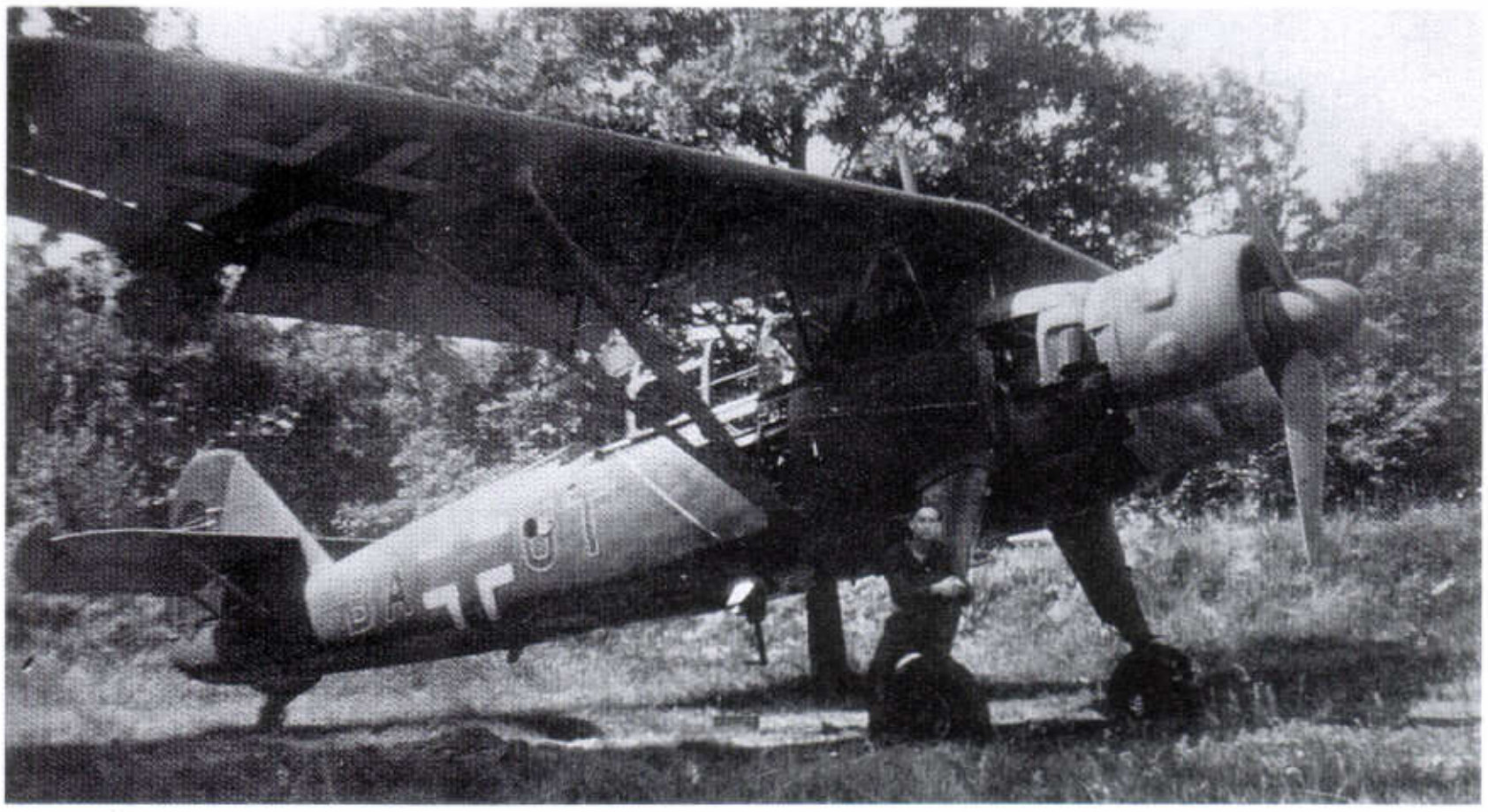
69: *Pictured in late 1939, at first glance this Bf 109E appears to be an overall dark green but the subtle difference between RLM 70/71 can be seen on the wing root and flap. The aircraft carries standard insignia for the period, except for the personal emblem of a gun-toting angel and grossly oversized wing Balkenkreuze. These were not uncommon on several types of aircraft at this time, probably on account of a mis-interpretation of the official instructions and the hope that such markings would prevent mistakes by their own flak and aircraft* *(see page 152)*

70: *Junkers Ju 87B-2s of 5./St.G.2; T6+GN, WNr. 5486, in the foreground, somewhere near Bonn in winter 1939-40. All wear standard 70/71/65 with all visible swastikas and Balkenkreuze with thin black borders. The letter 'G' had a thin white border and unusual proportions when compared with the official style shown on page 151*



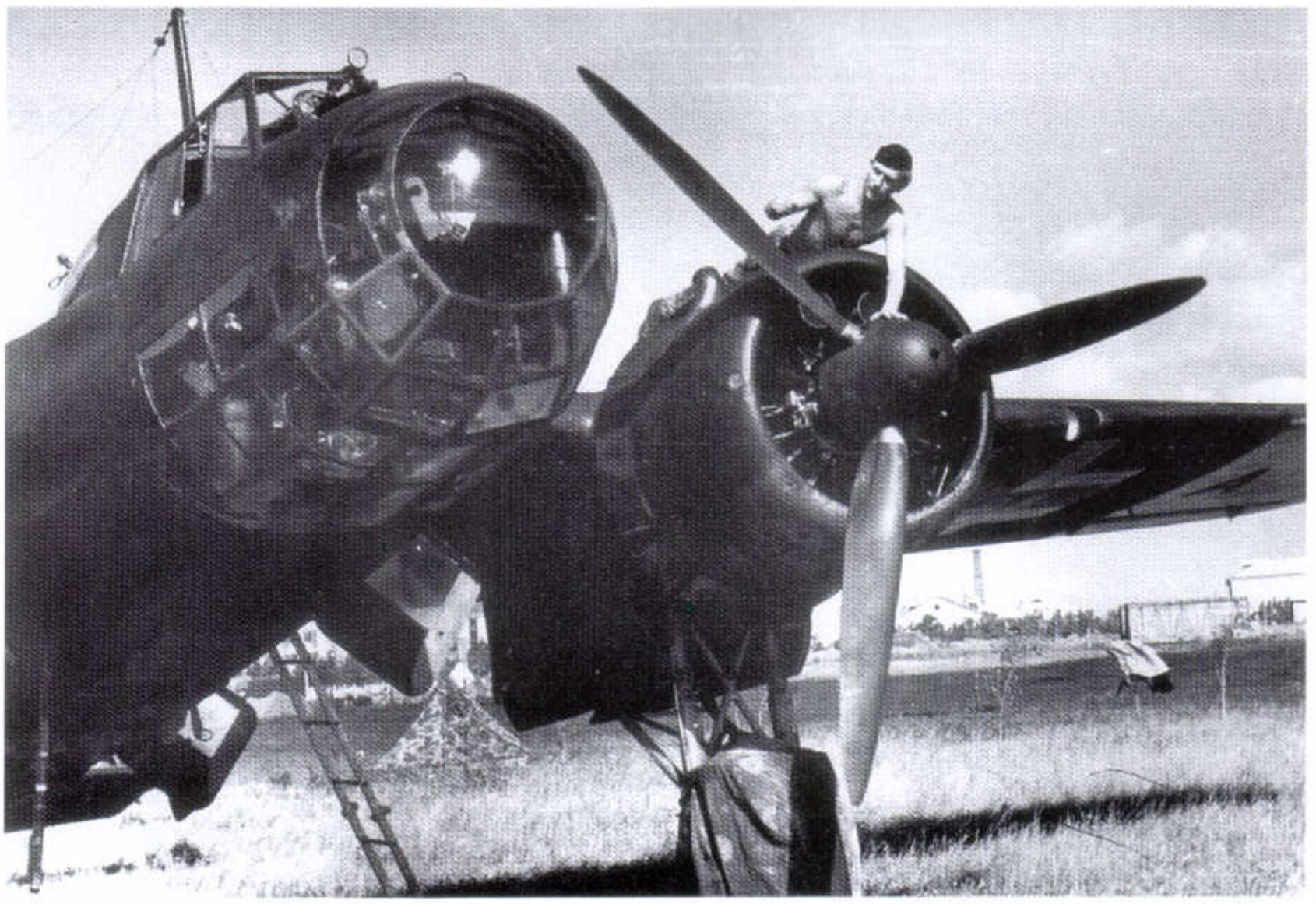
71: *Another example of the close tones of RLM 70/71 giving a false impression of a single overall colour. This Henschel Hs 126A-1 from (H)/23 very early in the war is finished in the two standard greens, as part of the camouflage pattern 'B' (shown on page 17) can be seen near the observer's cockpit and on the engine cowling. The light tone of the underside RLM 65 and the use of an auxiliary bomb rack at the base of the wing strut are noteworthy*

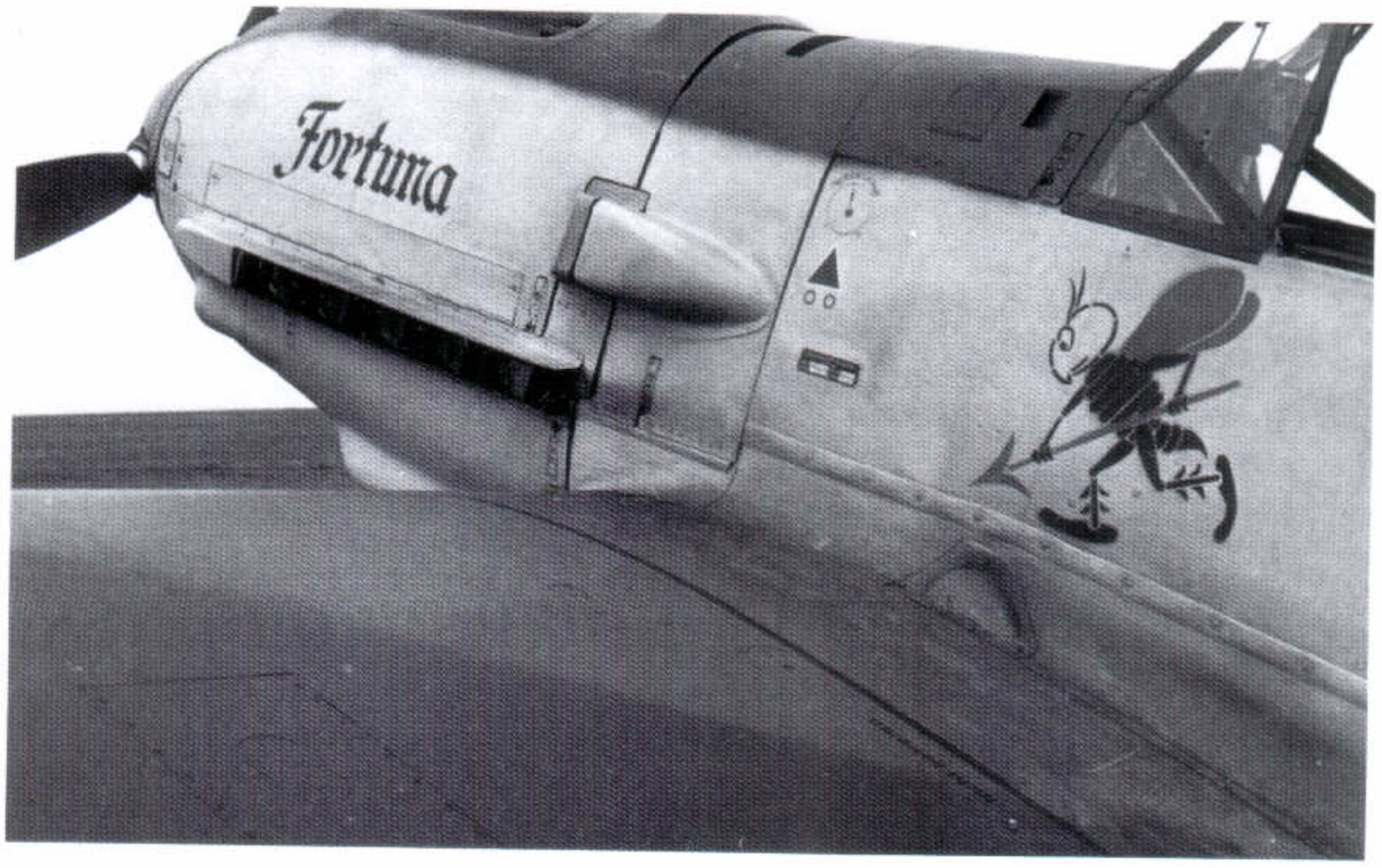
72: *An abandoned Henschel Hs 126, BA+UT, of an unidentified unit, probably a training school, as the white outlined codes are typical of those used later in the war by training units. The fuselage Balkenkreuze has a dark centre, possibly a darker green in line with the instructions concerning the simplification of insignia. It is possible that the aircraft has been repainted an overall green on the upper surfaces. The propeller and spinner appear very pale in tone, perhaps as a result of weathering*



73: *Henschel Hs 123A, CA+AW, 'White 25', WNr 2303, from the Stukavorschule at Bad Aibling in 1941-42. It carries a much patched up 70/71/65 colour scheme (AMC)*

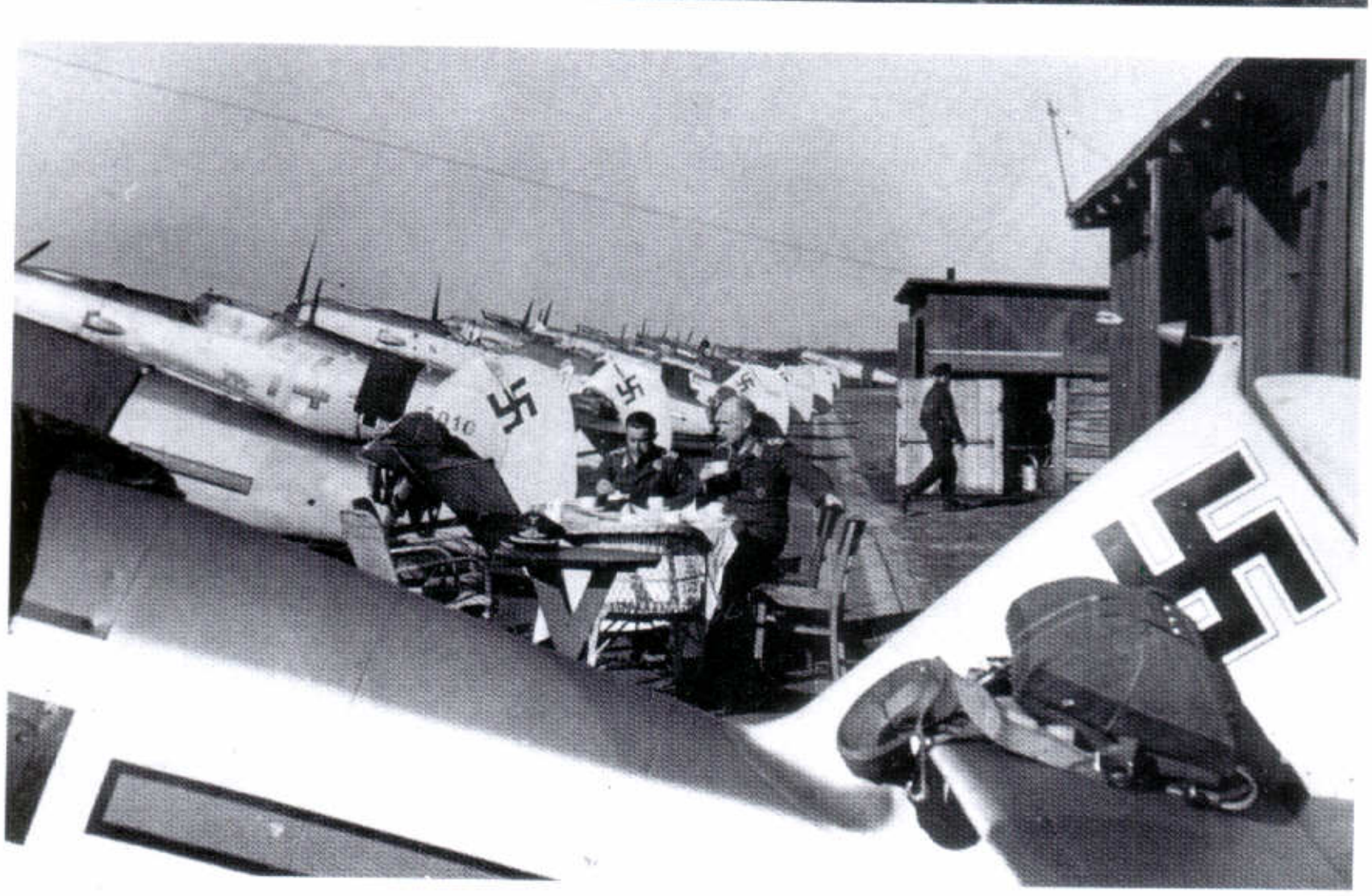
74: *A Dornier Do 17P during an engine run displays the later standard camouflage scheme of RLM 70/71/65. The yellow(?) ring on the spinner may be a staffel marking*





75: *This Bf 109E-4 of III./JG 3 is pictured in France in 1940. The aircraft is finished in RLM 70/71/65, the latter being of the later 1941 shade. The intended matt finish to the paint is clearly visible and it is apparent that all maintenance stencilling is still in place. Note the Gruppen 'Stechwespe' emblem is painted in Schwarz 21, with wings and spear in Hellgrün 25*

76: *A Bf 109 E-1, believed to belong to II(J)/186(T), at Nordholz in Germany in winter 1939-40. Camouflage appears to be 70/71 or possibly 02 with 65 fuselage sides. This may have been applied at unit level as the swastika has a white frame but no visible thin black border. The underwing Balkenkreuz has the thin black border*

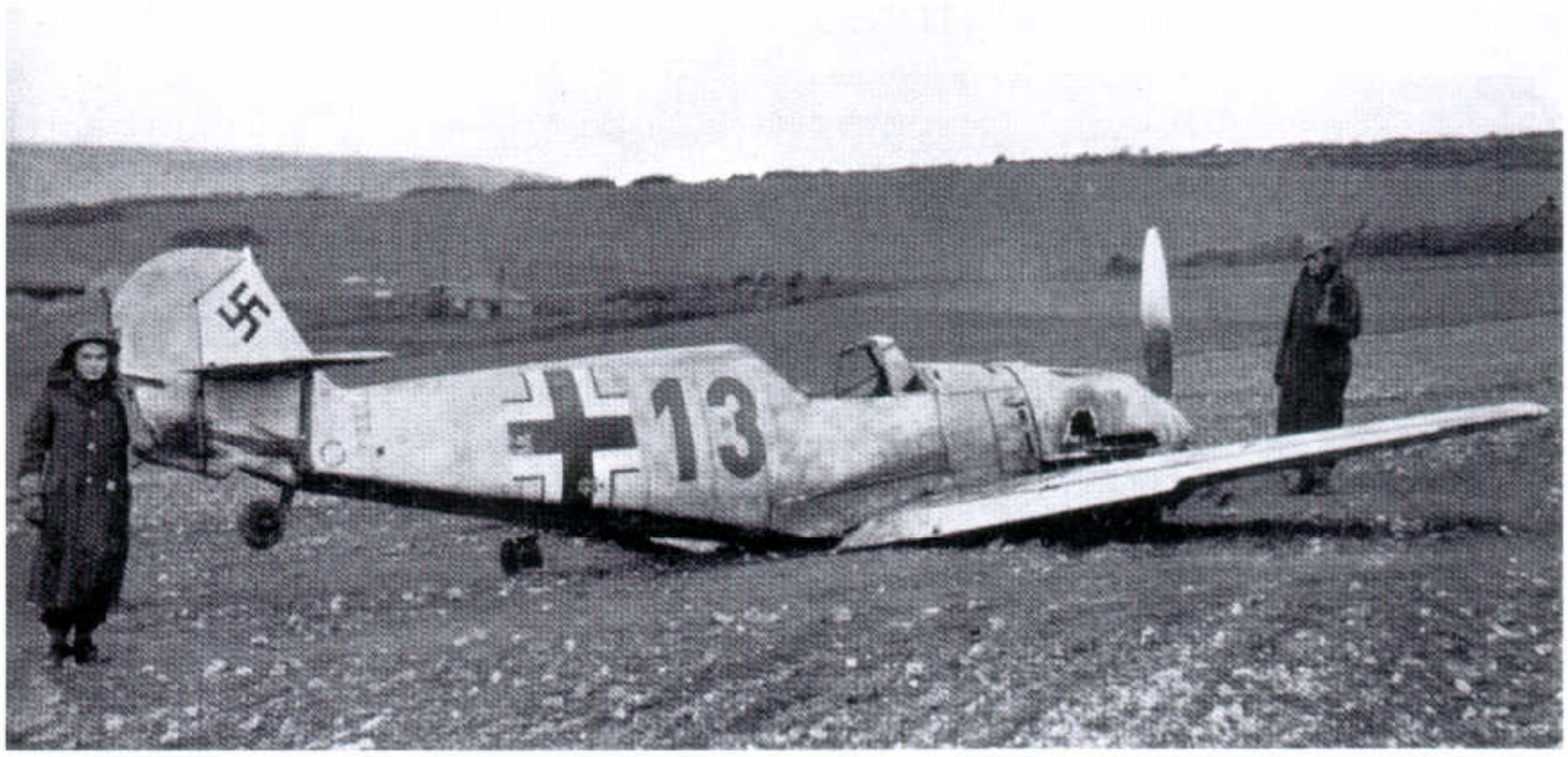


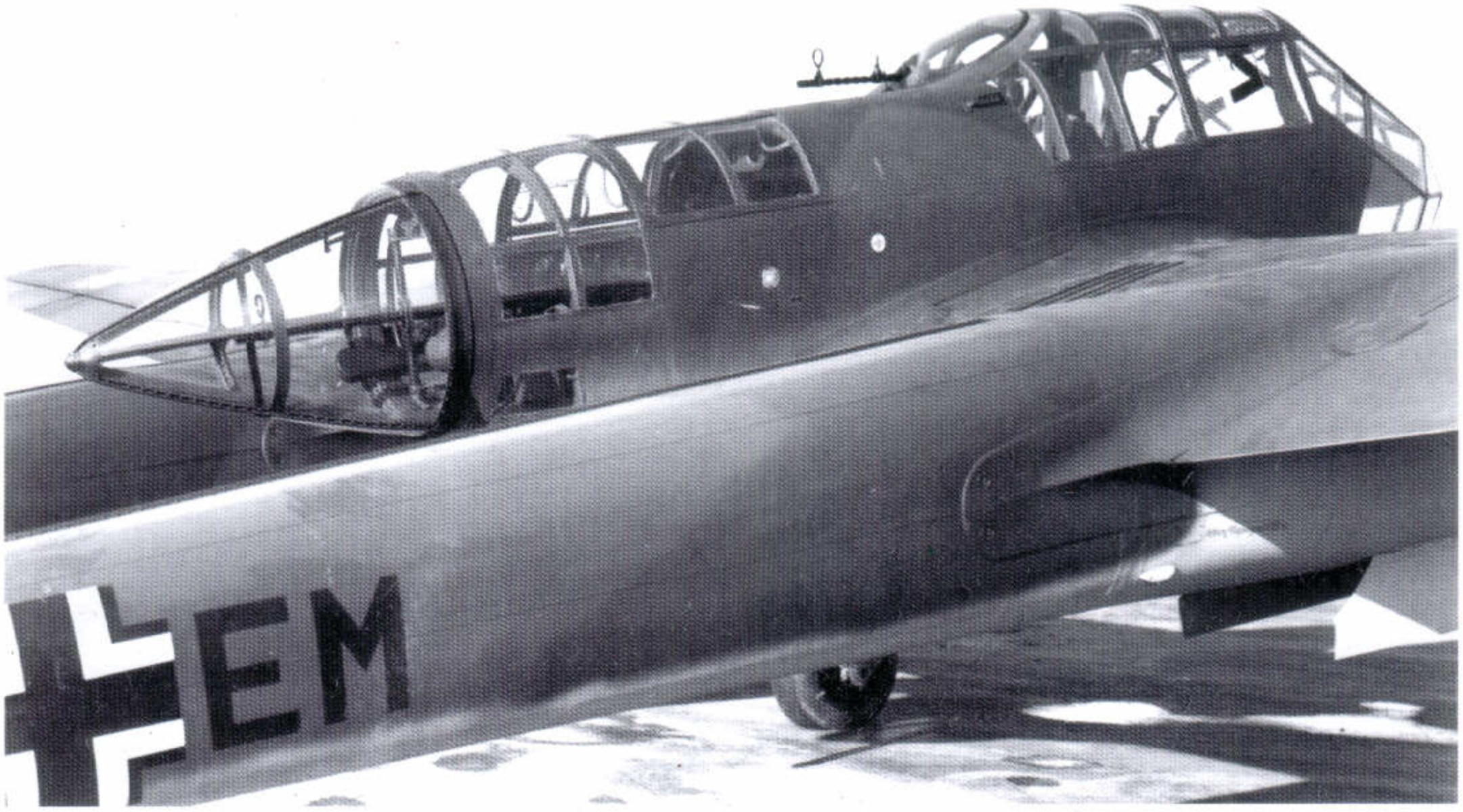
77: *New-looking Bf 109E fighters of II/JG 26 on an unidentified airfield, probably in spring 1940. All appear to have a 71/02/65 camouflage. Swastikas are in the official style as shown on page 152 but vary in position. 'Yellow 14', has a 'pre-war' style of Balkenkreuz and the swastika in the centre of the tail. Behind is 'White 1' of 4. Staffel, with a Staffelkapitän's pennant on the antenna mast. The Werk nummer, 1489, is carried, unusually, on the rudder, with the swastika on the fin and an 'early war' style fuselage cross. Further back WNr 5063 also carries the number on the rudder and the swastika on the fin*

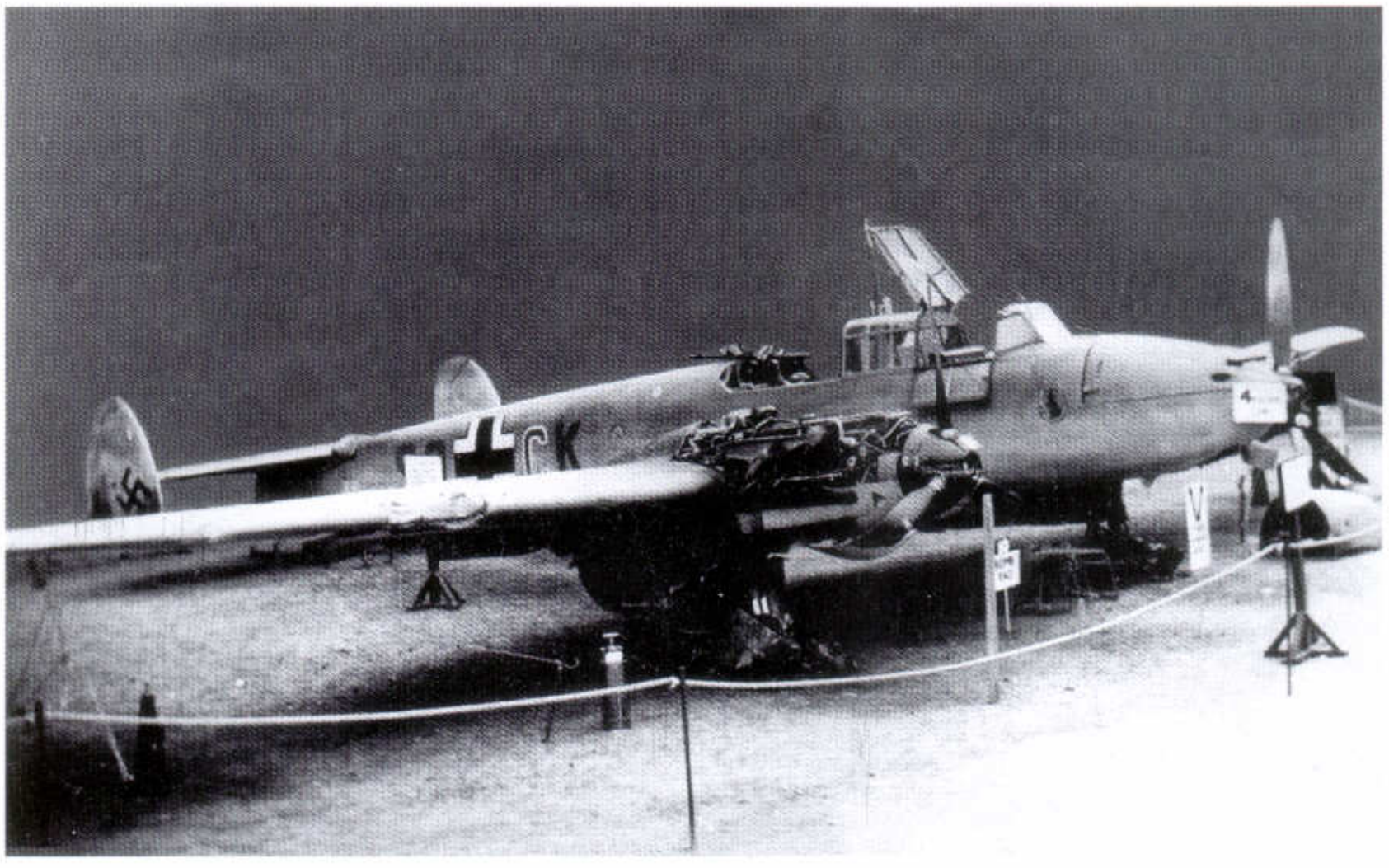
78: *A posed picture taken during the Battle of Britain period of a Bf 109E-4 of 4./JG 77. 'White 1', WNr 1365, appears to wear a 71/02/65 camouflage with completely standard national insignia for the period*

79 Below right: *This Bf 109E-4, WNr 5104, 'Red 13' of 3./JG 77, was shot down in Sussex on 25 October 1940. It wore 71/02 on the uppersurfaces with a patchy 65 overspray to the fuselage which was beginning to wear away in places to reveal an original coat of green paint. The rudder and engine cowling were 04 Gelb*

80 Below: *A very sharp detail photo of an Fw 189 in 70/71/65. The photo shows many details normally not visible. Balkenkreuz of the 'early war' type with black border and the camouflage pattern of 70/71 which had been sprayed by hand using chalk marks. Note the uneven colour demarcation visible in the middle of the picture. Inside of the cockpit was painted in RLM 66 according to L.Dv 521/1 issue 1941*



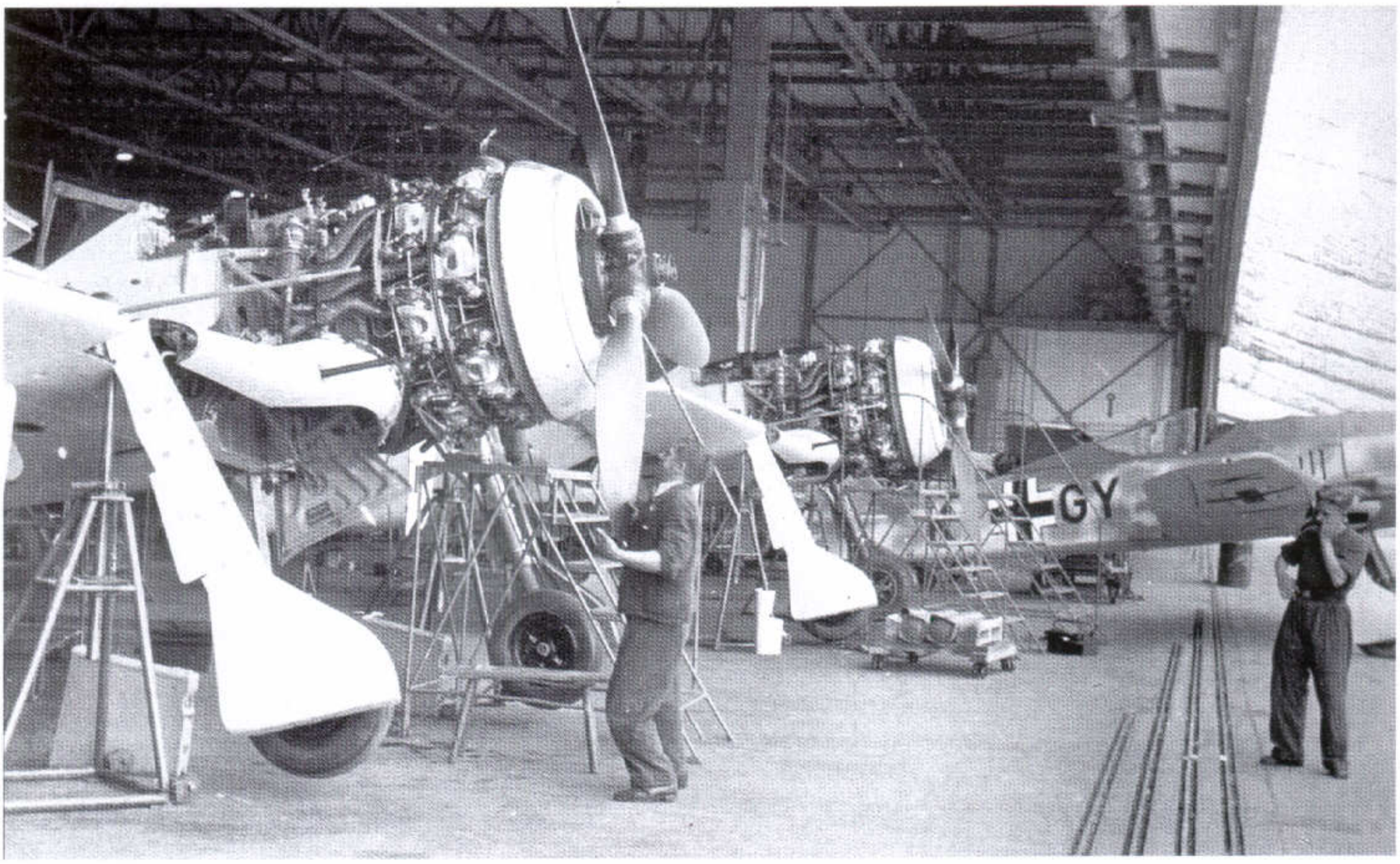




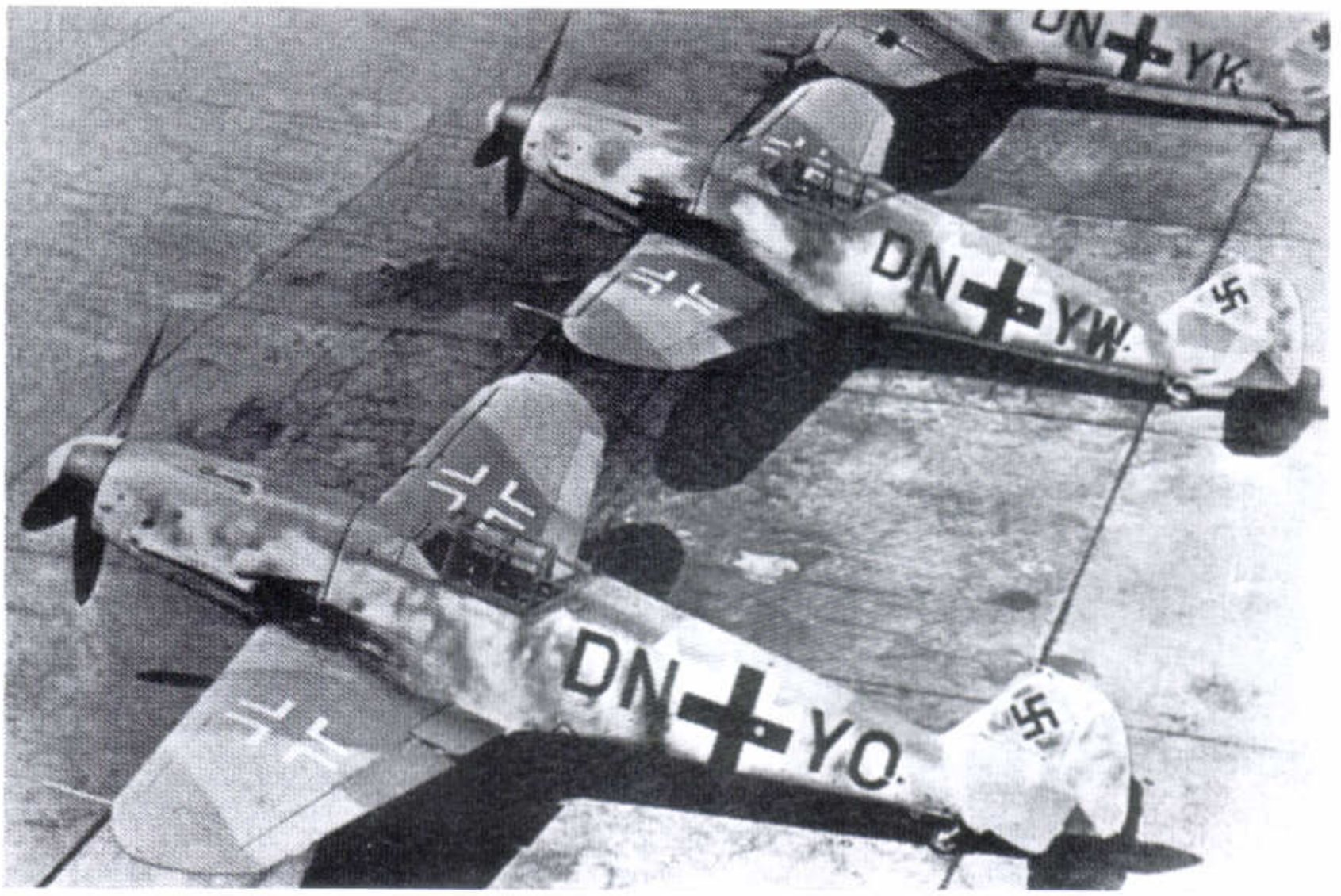
81: *Seen on display in Hendon, this Messerschmitt Bf110D, WNr 3341, S9+CK, of 2./Erp.Gr 210, was shot down over England on 15 August 1940. Both crew members escaped injury to become prisoners. It is most probably camouflaged in 71/02/65 with the fuselage sides and fins in a mottle of all three colours.. National markings are all as regulations required, with the individual aircraft letter, 'C', outlined in white*

82 Left: *A Bf 110C or D, probably in service with a training school. Is the camouflage 71/02/65? Or because of the strong contrast with the snow covered airfield, 74/75/76? The Balkenkreuz is in the early style with thin black border, as is the swastika*

83 Below: *Early Fw 190s in production at the Focke-Wulf works at Marienburg. Two are probably overall 76, while the most complete wears 74/75/76 as the OS list*

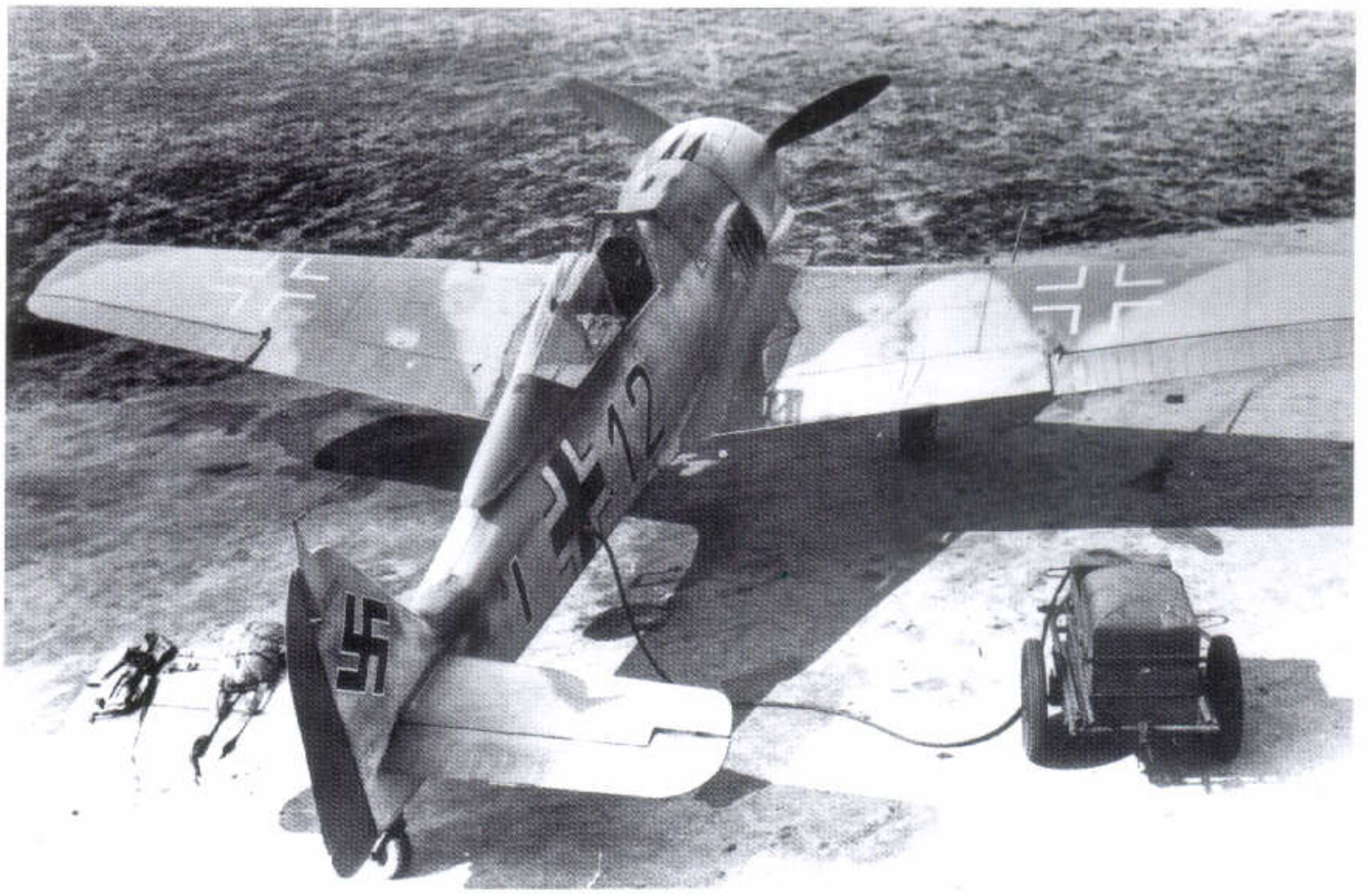


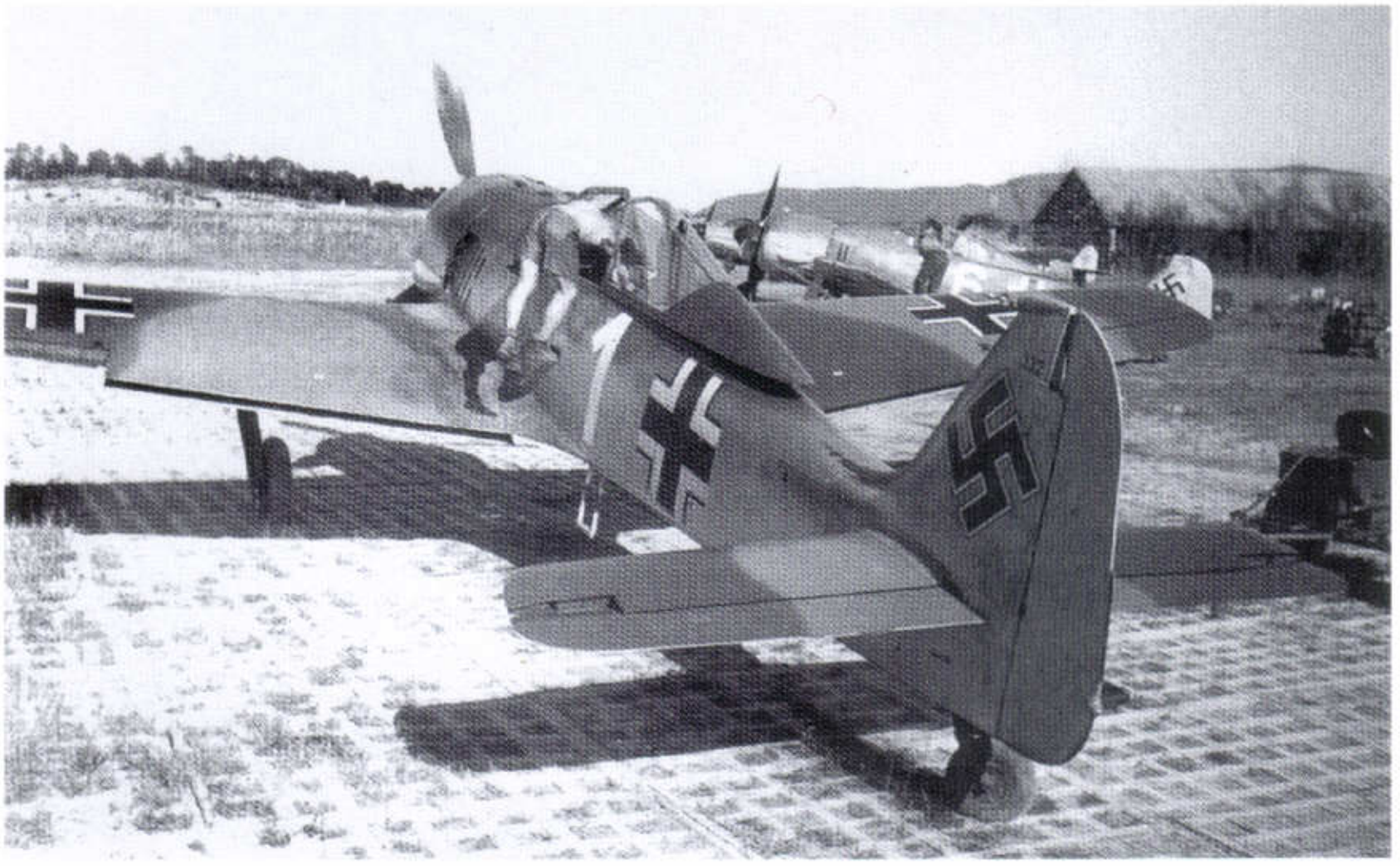
84: *A line of brand new Messerschmitt Bf 109G-1s in summer 1942. All are finished in 74/75/76 camouflage with additional 02 and 70 blotches on the fuselage sides, in accordance with the OS Liste. Note the use of the simplified Balkenkreuze on the wings on the nearest two machines and the omission of the thin black outline on those on the fuselage. Each aircraft is marked with a delivery code in washable paint, as described on page 170. Spinners are RLM 70 with one third in white and the tip in 76*



85: *This Fw 190A-1, WNr 067, is seen ready for delivery to JG 26 in the late summer of 1941. Lt Michalski of 4./JG 26 was shot down and killed in this aircraft, by then marked 'White 5', on 10 April 1942. As shown here the machine wears standard markings and delivery codes. Camouflage is probably 71/02/65 but could be 74/75/76, with the fuselage mottle being unusually fine and marked by engine exhaust staining*

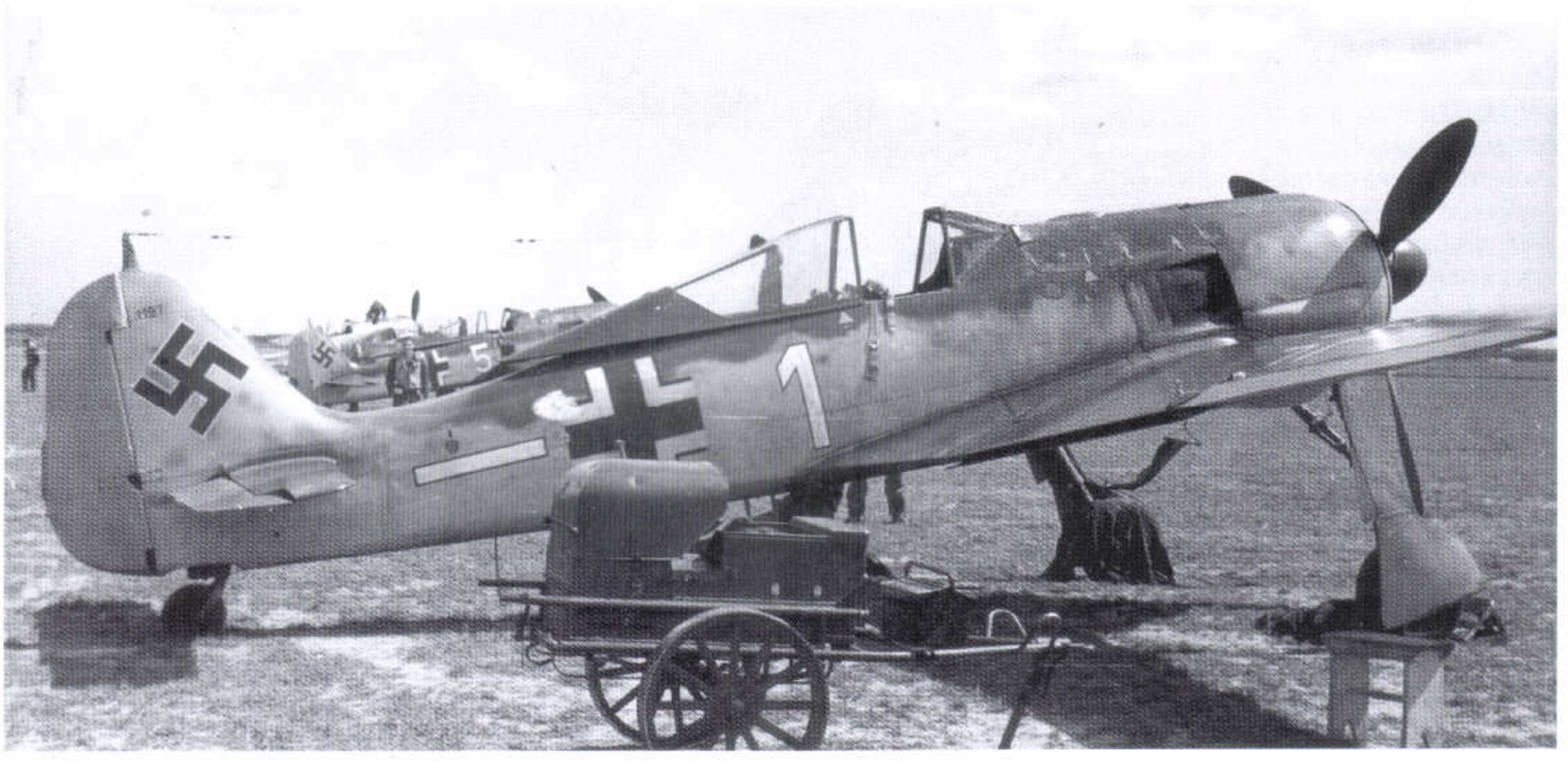
86: *An overhead view of Fw 190A-4 WNr 5735, 'Black 12', of 8./JG 2, flown by Hptmn Bruno Stolle while based at Brest, France, in late 1942-early 1943. The machine is finished in the by-then standard camouflage of 74/75/76 with appropriate unit markings and a yellow rudder. The national insignia on the wings are of the simplified style described on page 155. By 1943 the red numerals and vertical III Gruppe bar had officially been superseded by black. (See page 168) Note the pilot's lifejacket and parachute ready on the tailplane*

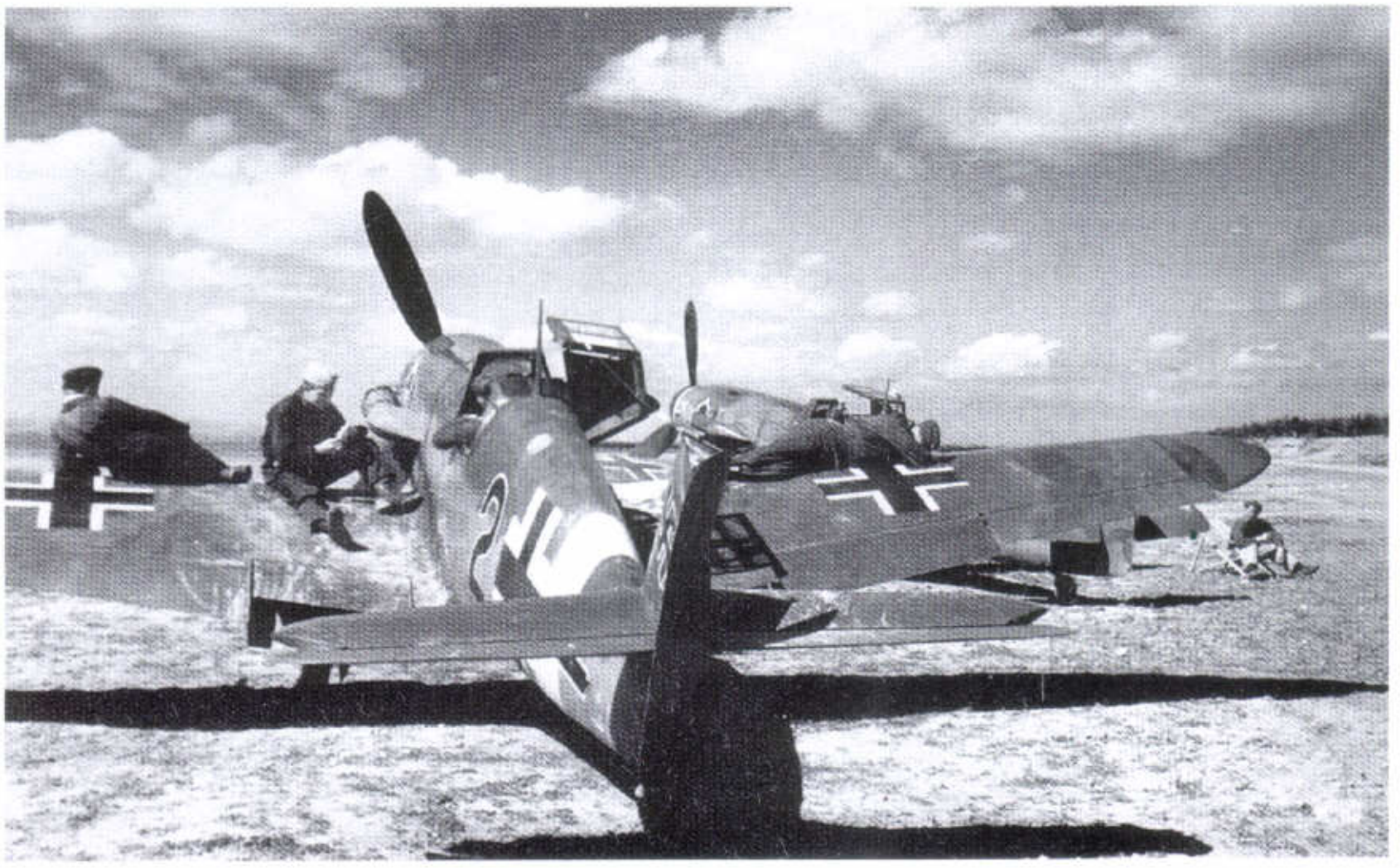




87: *The very high contrast between the colours on this Fw 190A-2 or -3, WNr 332, 'White 1' of JG 26 and the pre-war style of the wing Balkenkreuz may indicate the use of an RLM 71/02 camouflage scheme during the transition period of both markings and colours in 1941-1942*

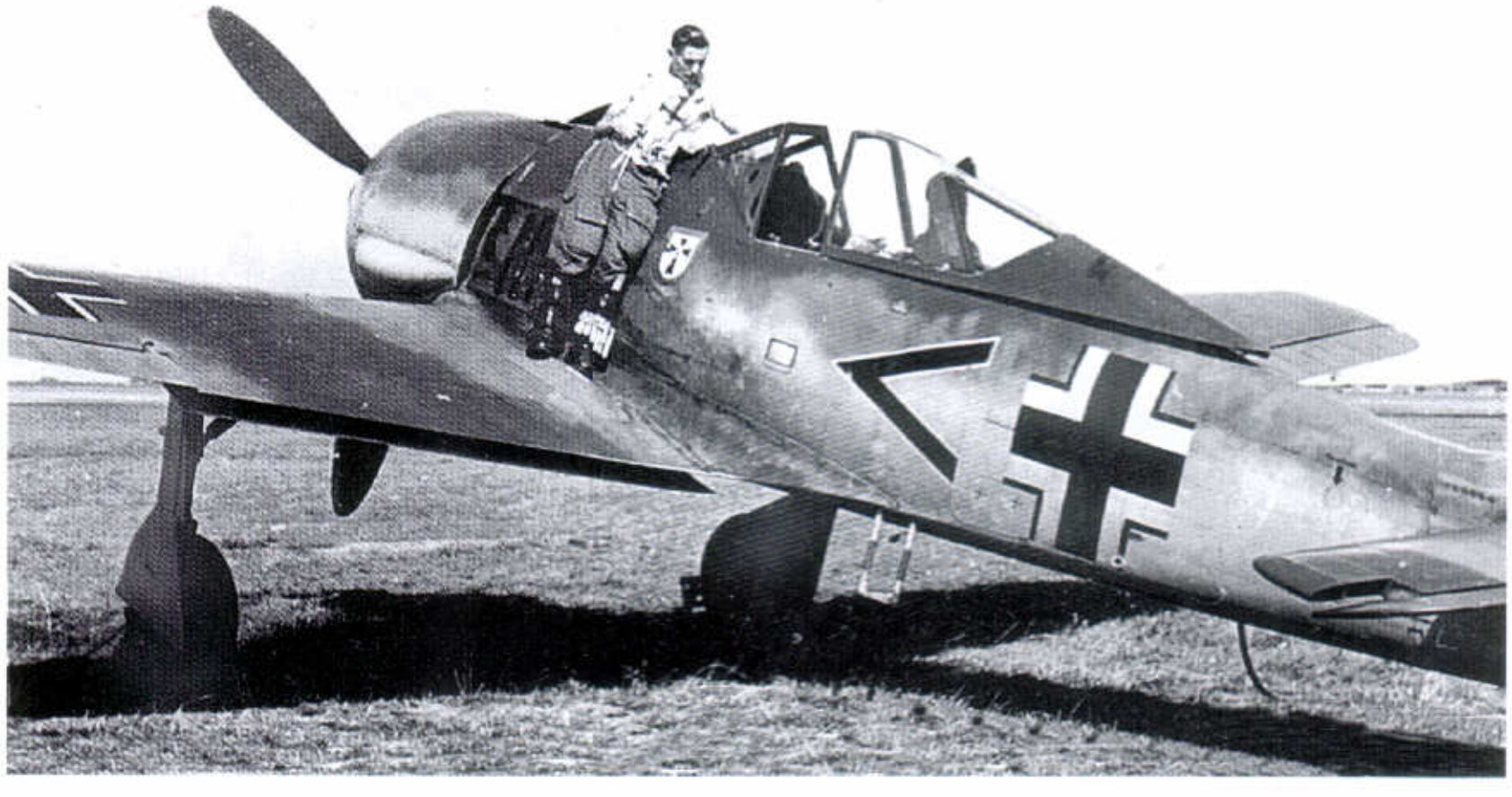
88 Below: *Fw 190A-5, WNr 1197, 'White 1' of* Oblt *Otto Stammberger, Kapitän of 4./JG 26 in France in early 1943 is probably camouflaged in 74/75/76 with entirely standard markings for the time. The rudder may be yellow. Note the gloss on the engine cowling and wing*



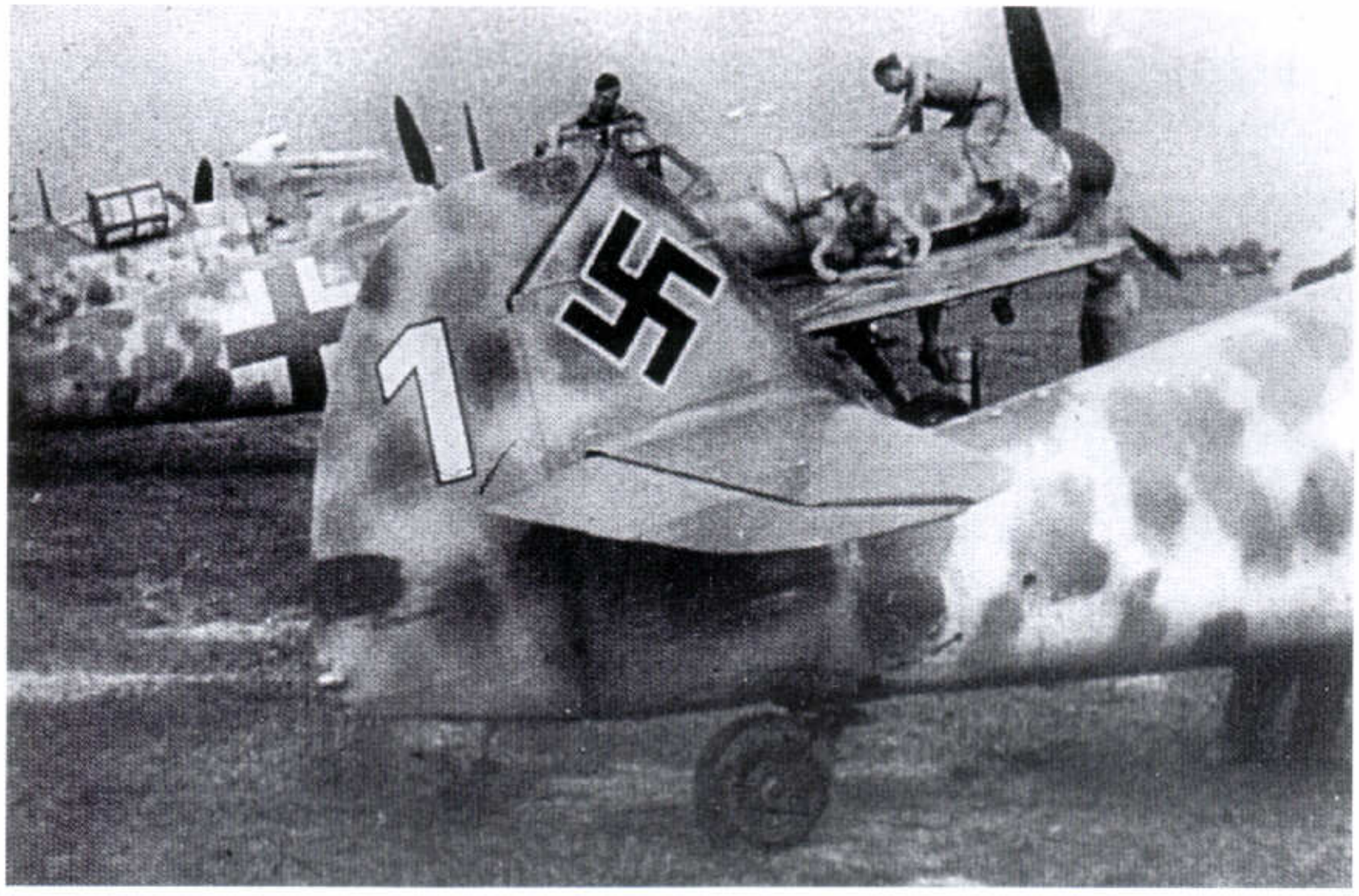


89: *Mechanics service a tropicalised Messerschmitt Bf 109G-2 of the 'alert rotte' of 5./JG 53, flown by* Ofw *Rollwage and seen at La Marsa in the Mediterranean in 1942. The uppersurface camouflage appears to be well worn and is probably the original 74/75/76 but may be an in-the-field repaint job using 79/80 or some of the Italian paints. Note the use of the early war style Balkenkreuze on the wings*

90: *Also shown in 1942, this is Fw 190A-2 WNr 0495, used by Uffz. Heinz Hanke, Gruppenadjutant of III./JG 1. The high tonal contrast between the colours may indicate that the aircraft was finished in an interim scheme of 71/02/65. It could however, also be in the 74/75/76 scheme with faded or lighter 75. The adjutant's chevron is in accordance with the regulations applicable to fighter unit staff aircraft (see page 168), yet the wing Balkenkreauz are still in the 'pre-war' style*

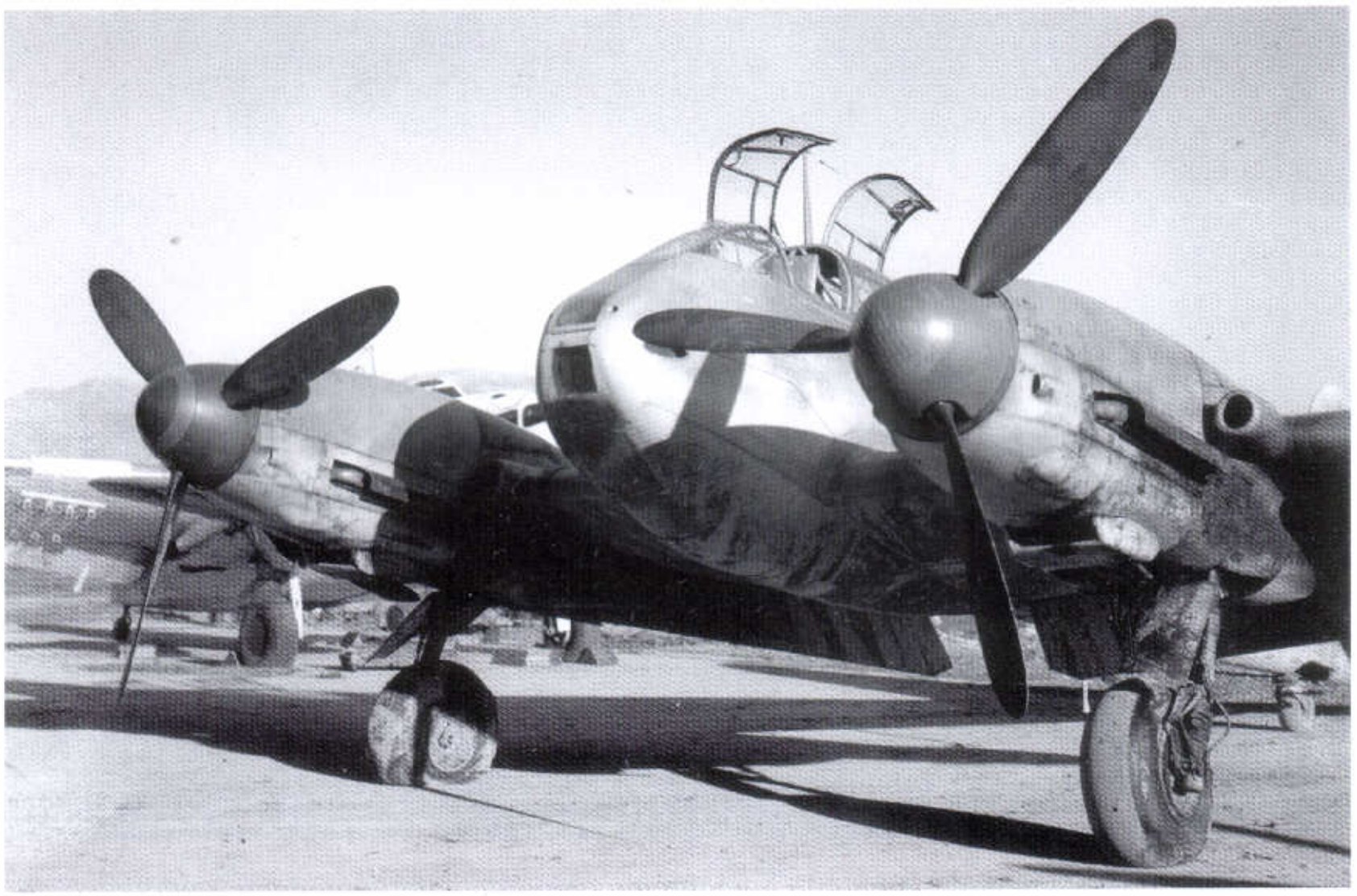


91: *These Bf 109G-5s are possibly from 1./JG 50 in October 1943. The non-standard position of the aircraft identity numbers on the rudder was favoured by the jabo staffeln of several units. The camouflage pattern is clearly the standard 74/75/76 with additional mottling in 71 and 02*



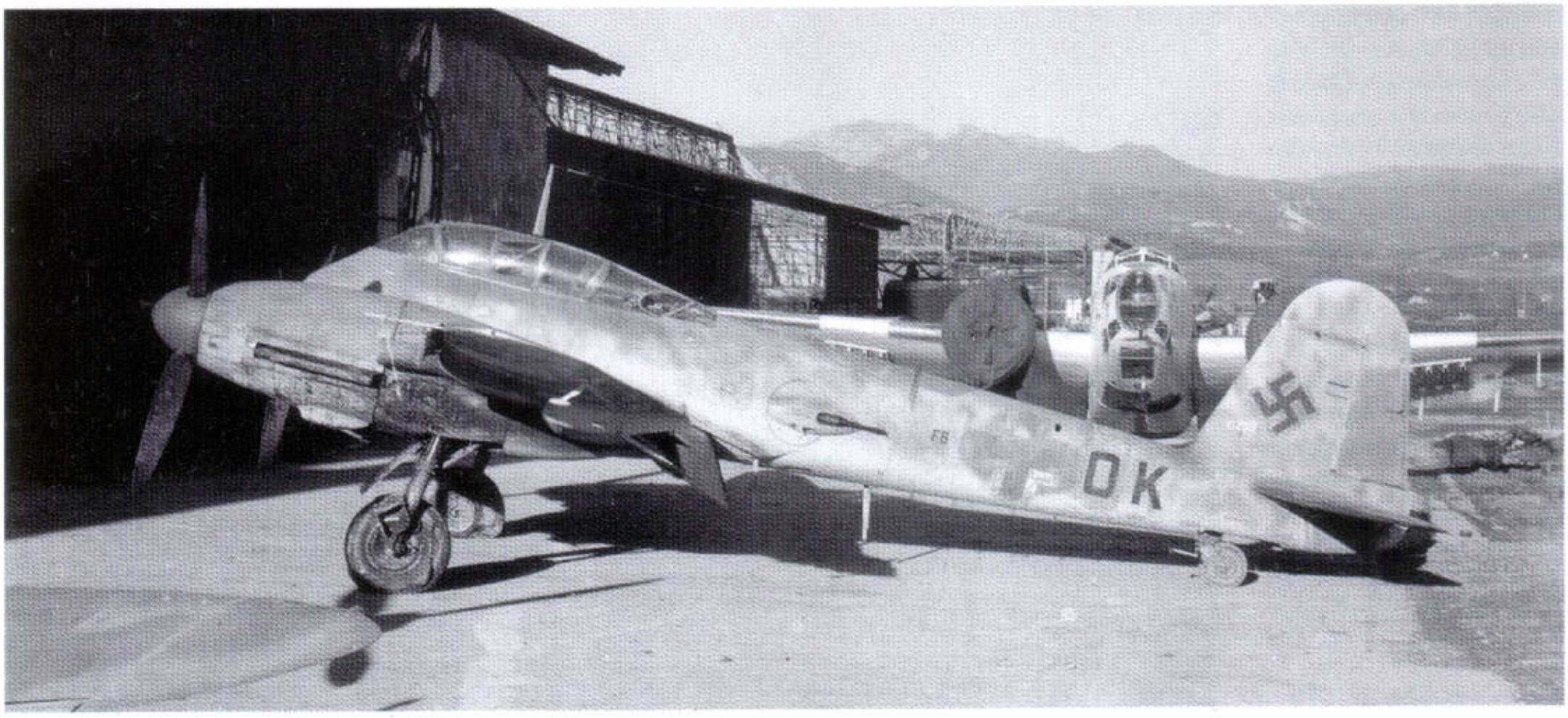
92: *JG 54 was famed for its imaginative unit camouflage schemes. This one on a Bf 109F-2 of the Stabschwarm of II Gruppe is no exception. It carries a pattern first used on the unit's Bf 109Es, apparently consisting of patches of RLM 02 added to the fuselage sides with a network of either 74 or 75 over the 76 base colour. Points worthy of note include the yellow Eastern Front theatre fuselage band, non-standard style chevron and glossy finish—note the reflection on the wing root. Note also the 'Lion of Aspern' Gruppe emblem*

93: *JG 3 also had some unusual ideas about camouflage. This Bf 109F of the Geschwader Kommodore, Major Hans von Hahn, has acquired circles of RLM 74 or possibly a dark green over the original 76 on the fuselage sides. The dark tone has also been brought up from the wing root onto the fuselage, probably in order to disguise exhaust staining. The command markings are also non-standard, the triangle being a unit-level invention. Note the much lighter tone of the 75 grey on the wing compared to that on the fuselage, and the early-style wing Balkenkreuz*



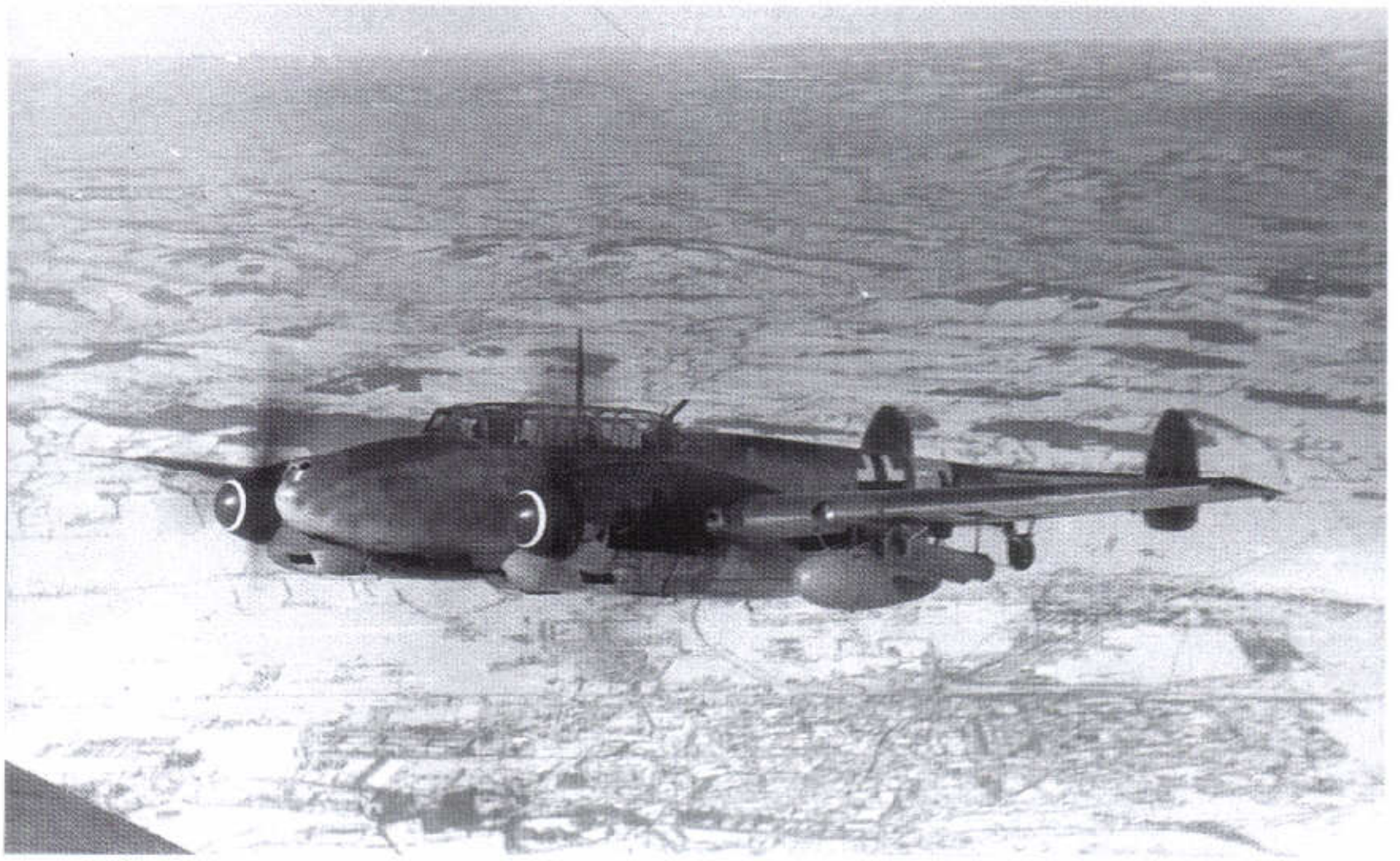
94: *Messerchmitt Me 410A-3, F6+OK, WNr 10259, of 2.(F)/122, seen shortly after it was captured in Sicily in November 1943. It is finished in the standard camouflage of RLM 74/75/76 with a ring on each spinner painted in red 23, the staffel colour*

95 Below: *This side view of F6+OK shows how non-descript the RLM 74/75/76 scheme appeared, even the national and unit markings have been obscured with a light overspray of grey. The white Werk Nummer on the fin is barely visible. Note it has been applied parallel to the ground line. An all-white RAF Hudson gleams in the background*



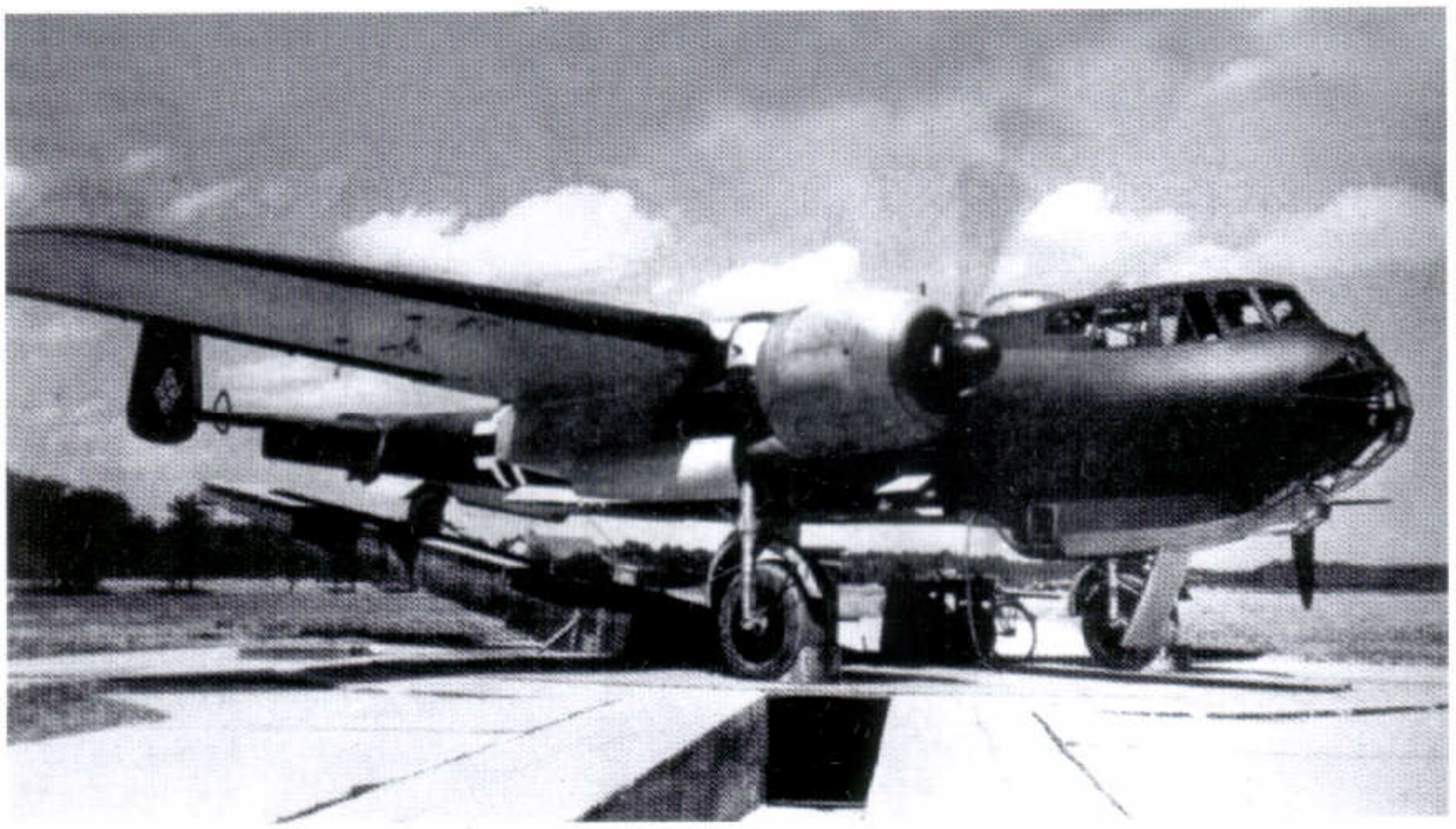
96: *A flight of Messerschmitt Bf 110G-2s of 6.ZG/76 fitted with WGr 21 rocket launchers in flight over snow-covered Germany in winter 1944. The aircraft are all finished in the fighter camouflage of 74/75/76 and wear yellow fuselage bands. The nearest aircraft wears the maximum simplified fuselage Balkenkreuz, a requirement confirmed by Sammelmitteilung 2, but the swastika is still in the earlier black outlined style*

97: *A Messerschmitt Bf 110G-2/R3 heavily burdened with additional guns, WGr 21 mortars and a pair of extra fuel tanks. Seen over Germany in winter 1944, the aircraft is finished in 74/75/76 with red propeller spinner tips and white rings. Note that the fuselage Balkenkreuz still has a black centre and outlines*



98: *10 August 1943. The crew lounge under a Messerschmitt Bf 110G-2/R3 day interceptor of ZG 76, fitted with twin MG151 guns in the belly pack and WGr 21 mortars. The aircraft is finished in 74/75/76 with a thick white ring on the propeller spinner tips. Comparison with the tone of the propeller spinners suggests that some of the fuselage mottle is in RLM 70*

99: *This is one of the earliest Ju 90s (note the faired nose landing light) in service as a troop transport on the Eastern Front. It apparently still retains its Lufthansa 01 Silber finish with the addition of RLM 02 to the nose forward of the wing, prior to being camouflaged overall in standard 70/71/65. The engine cowlings appear to be still in their original black Lufthansa finish with the addition of Gelb 04 theatre markings, the same colour being applied under the wingtips*



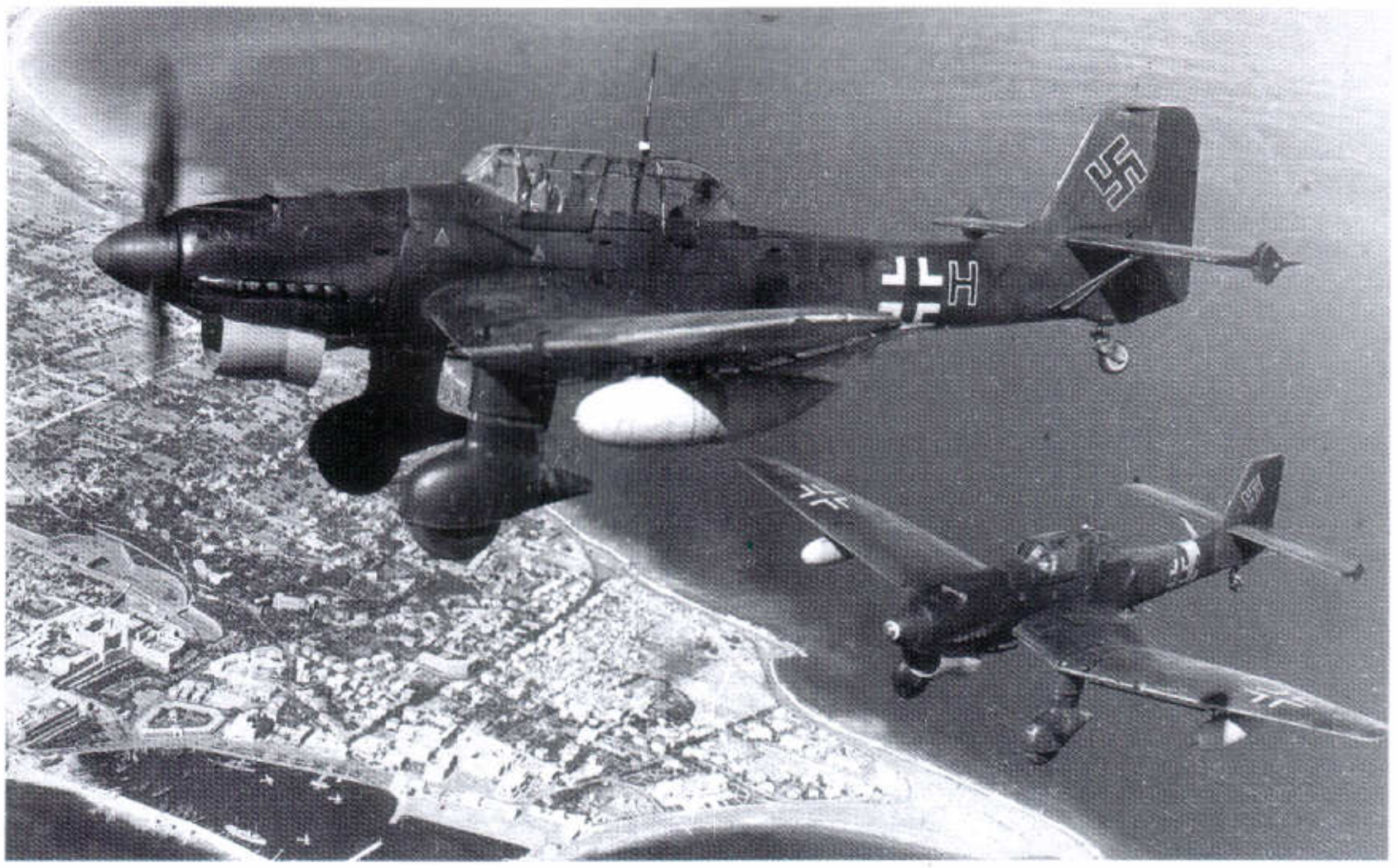
100: *A Dornier Do 217E on the compass-swinging platform at Frierichshafen-Löwental prior to delivery to the Luftwaffe. The machine was supposed to be finished in RLM 72/73/65 but apears to be overall 72 on the uppersides. The starboard engine cowling is still in primer finish. While the fuselage cross and swastika are in place, there are no underwing markings showing. These may yet have to be applied or may have been censored from the picture*

101: *This Dornier 217E-3 is apparently finished overall in RLM 65 (1941 version), including the engine cooling fans, with no markings visible. A few aircraft were actually delivered to KG 2 and KG 40 for service in this colour scheme, which was not inappropriate for use over the ocean. Note how the bomb bay doors fold*

102: *This overhead view of a Dornier Do 217E-1 shows a not entirely standard 72/73 camouflage pattern (compare with the official version on page 4) and also the extended tail cone containing the dive brake. The white number '44' in the centre of the fuselage Balkenkreuz is probably an abbreviated werk nummer; the markings, including the Stammkenzeichen code on the fuselage, are otherwise standard for a mid-war aircraft on a test flight prior to delivery. Note the absence of a black outer line to the wing Balkenkreuz*

103: *This Dornier Do 217E-1, WNr 0069, U5+DN, of 5./KG 2, forcelanded at Jury's Gap Sewer near Rye in Sussex on 12 October 1941. It was finished in RLM 72/73 on the uppersurfaces with a temporary black finish to the undersides (refer to page 106). This same finish was also used to obscure the fuselage markings. The swastika on the tail was exactly in line with prevailing instructions.* Lt *Dolenga and his crew were all taken prisoner; the aircraft went to Farnborough for examination. Six other examples also later served the same purpose at the RAE*

104: *A pair of Junkers Ju 87R-2s of 2./St.G 3 in flight over Trapani, Sicily, in May 1941. Both are finished in well-worn standard European camouflage of 70/71/65 and typical markings of the period. The nearest aircraft, S1+HK, has its individual letter outlined in white with a red spinner tip but has no white theatre fuselage band. S1+AK, behind, has the white band and also an additional white ring on the spinner, possibly to identify the Staffelkapitän's aircraft*



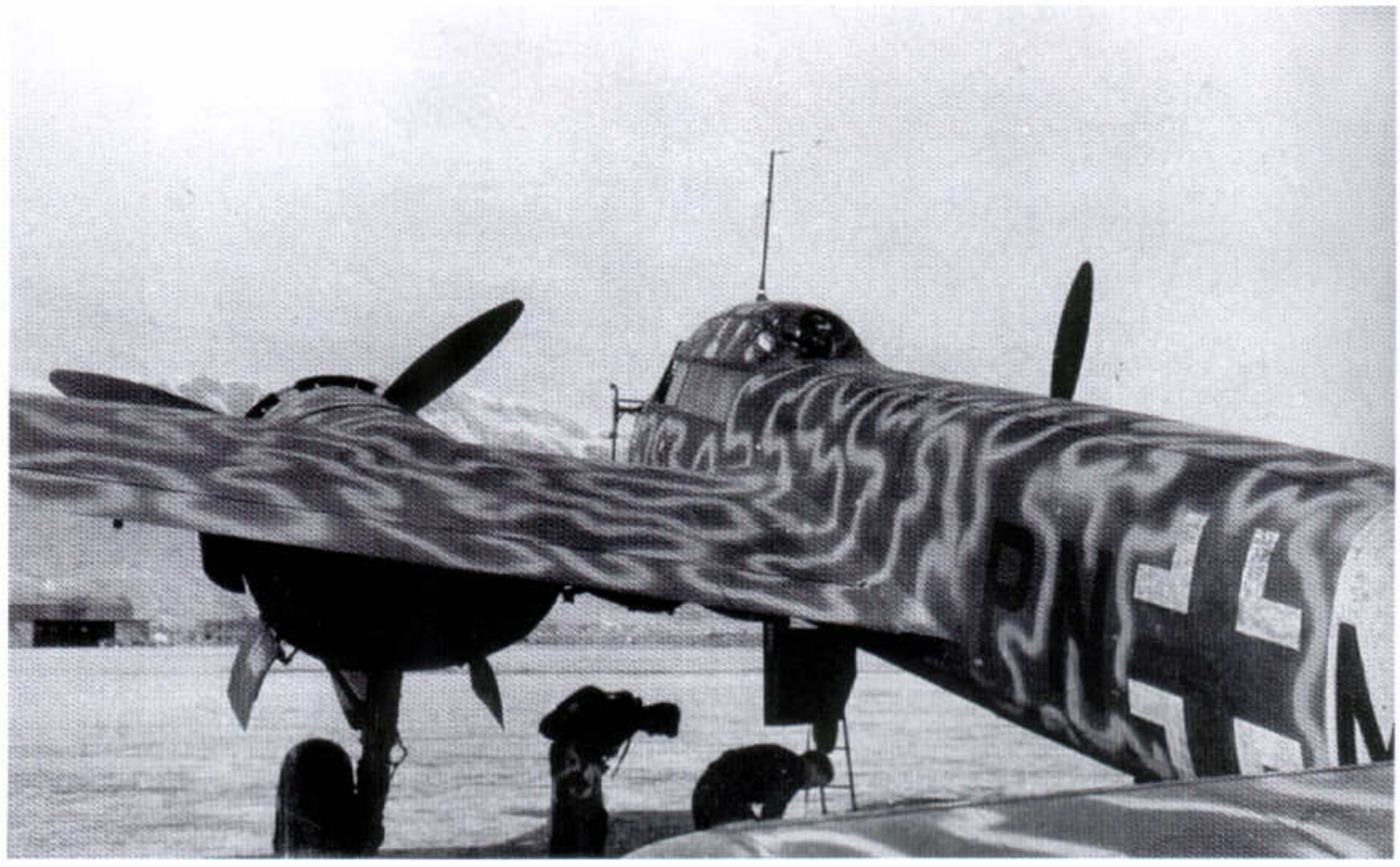
105: *The wreck of a Junkers Ju 87B or R of St.G 3, S7+K?, somewhere in the Western Desert. Despite the location, the aircraft still wears worn European standard camouflage of RLM 70/71/65, modified only by the addition of a white 21 theatre identity band on the fuselage and a ring around the spinner in white, the staffel colour. The wing Balkenkreuz are of the early narrow style; all other markings are typical for the 1940-42 period*

106: *A fitter attending to the engine of a Junkers Ju 87G-1 tank-hunter. Although the official scheme was for the classic RLM 70/71/65, the aircraft shows signs of repainting around the stencilling on the air intake which may indicate that it is now one overall colour. A spinner ring in yellow(?) the staffel colour, can be just made out. The completely matt finish is worthy of note*

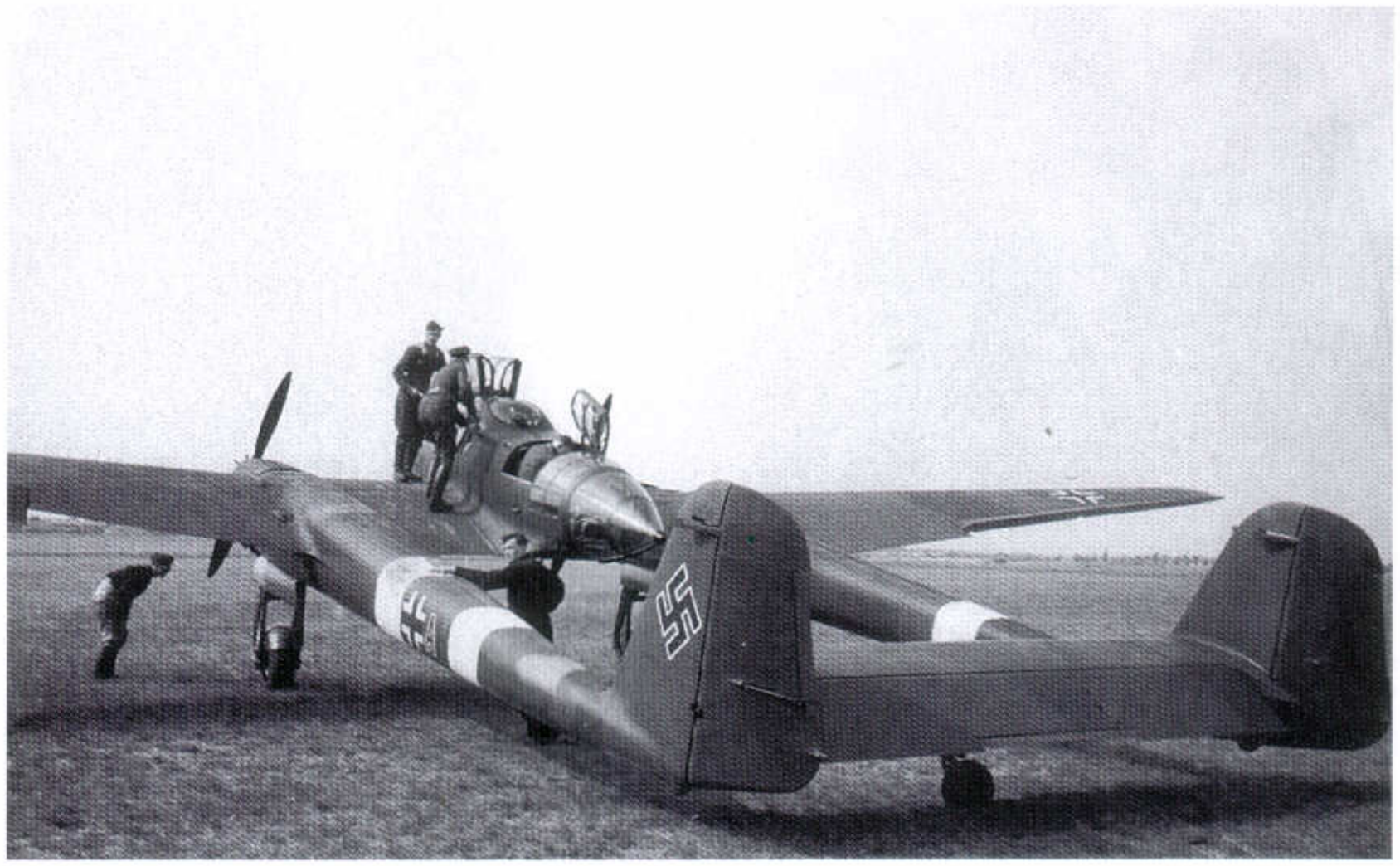
107: *A Ju 87D, S2+NM, of 4./StG 77 in 70/71/65 finish on a muddy airfield in Russia during the spring thaw. Mud and severe exhaust staining obscure the fuselage national marking, which is in the later simplified style using only the white angles (see page 155), as also is the swastika. Note that the machine in the background still retains its temporary white winter finish (refer to Chapter 9, page 99)*

108: *A well-worn He 111H, A1+JK, of 2./KG 53. It is finished in the standard 70/71 uppersurface scheme. The markings are of the early war period with a white outline to the last two letters of the unit code (verbandskennzeichen) and a white fuselage band. This probably indicates service on the southern sector of the Eastern Front in late summer 1943*

109: *This FuG 200 radar-equipped Junkers Ju 88A-6/U, WNr 4198, was in service with LG 1 in February 1944 at Aviano in northern Italy. Still bearing the delivery code 'PN+MT' it has been given a meandering spray of RLM 76 or 65 (late) or even possibly 02, in a pattern intended to mimic the effect of light on waves, over the original RLM 70/71 camouflage. It can be seen that the fuselage Balkenkreuz has been applied in the required white-only simplified pattern, which in turn has been lightly smeared over with a light grey to dull the brightness further*

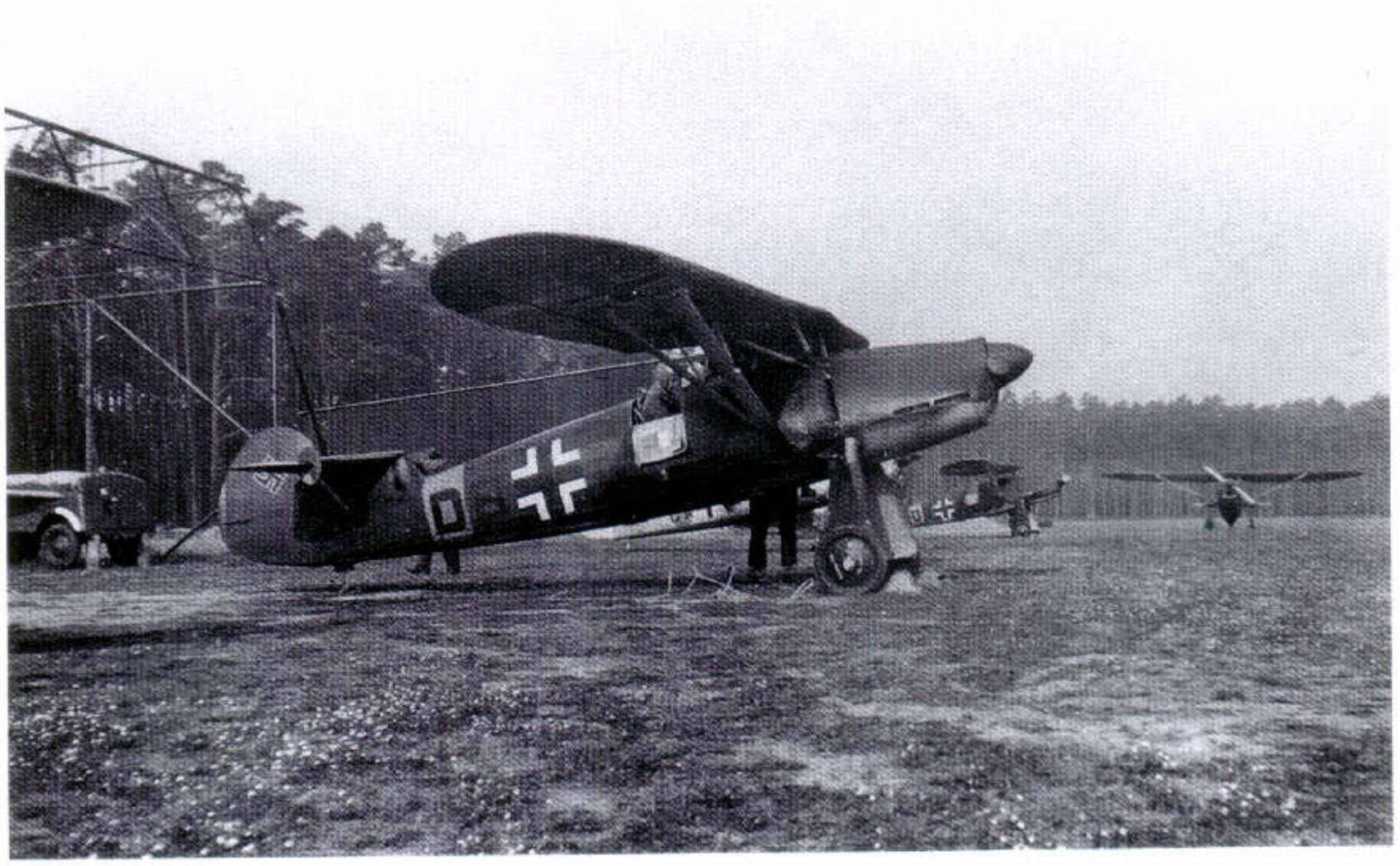


110: *Pictured somewhere in the southern sector of the Eastern Front in September 1942, this very clean Fw 189A-1, 'A' of the 1st Staffel of an unidentified short-range reconnaissance unit, is finished in RLM 70/71/65. For some reason it wears an additional white theatre band on the port boom. All markings are of the 'early war' type with thin black outlines*



111: *A Focke Wulf Fw 44C from FFS A/B 13 based at Pilsen, Czechoslovakia, 1940, finished in an overall 01 Silber (Paint Group 21) paint job as detailed on page 206. All visible Balkenkreuz are in the early war style. Code letters follow the official style exactly (see page 151)*

112: *Wearing an overall RLM 02 Grau finish, this Bücker Bü 131, KE+KT, of LKS 2 at Berlin Gatow in 1941, is a typical trainer of the early war years. The angle of the light makes the fuselage markings appear unusually pale (AMC)*

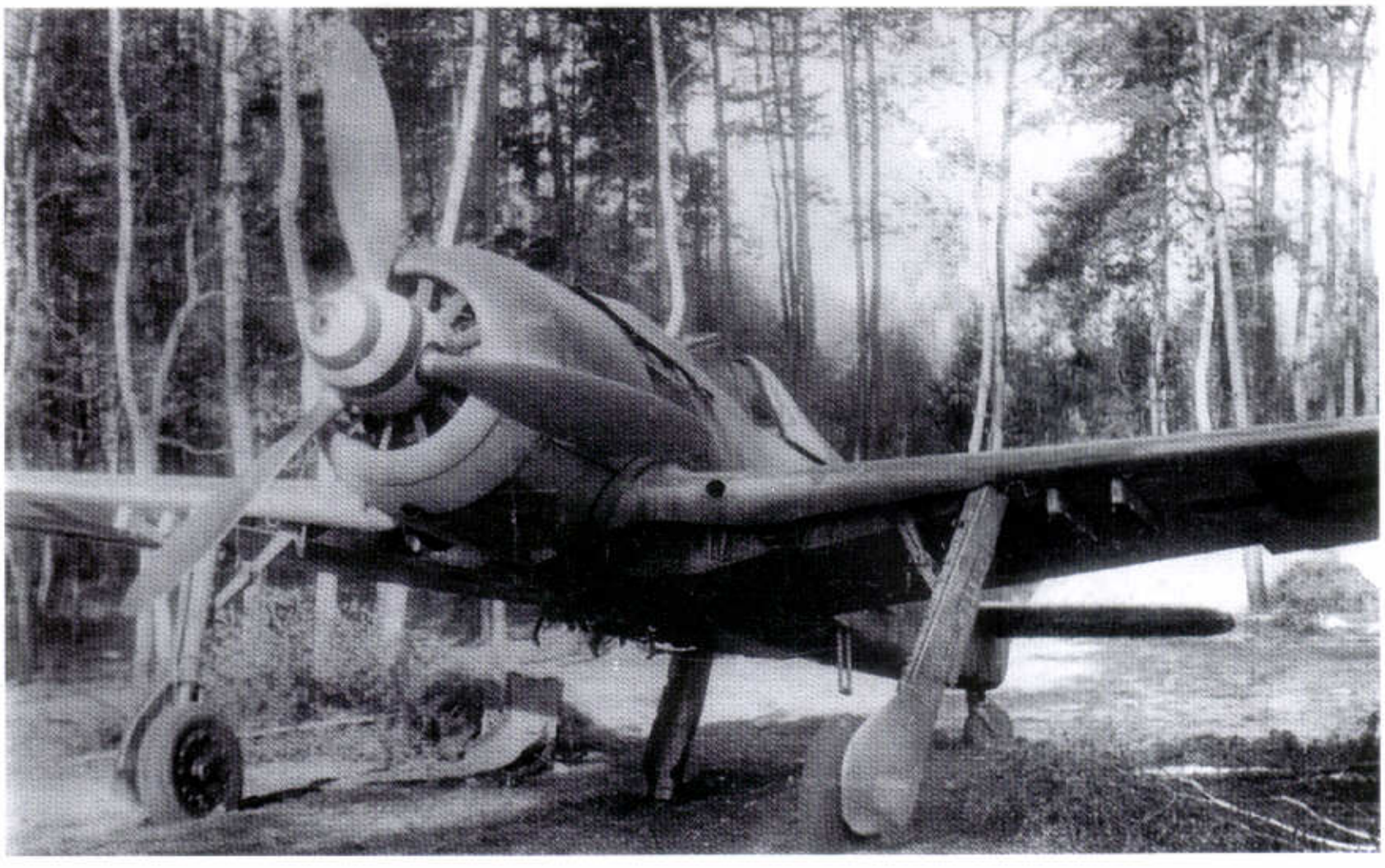


113: *A Focke Wulf Fw 56 of LKS 2 at Reinsdorf in 1942-1943 in a 70/65 camouflage. This is a good example of an aircraft camouflaged by the unit following the issue of an order on 21 January 1942 calling for such finishes to reduce their vulnerability to roving RAF fighters. Coded DB+??, it has a yellow fuselage band and lower wing tips. Behind is an overall grey example, CA+??, and further back another green finished aircraft, DB+??. Balkenkreuz and swastika are of the mid-war style (see page 155)*

114: *Pictured at Orange in France in March 1944, this ex-French Bloch 155 was in service with the Fighter Instructors School (Jagdlehrerüberprüfungsgruppe) based there. The aircraft is finished in the standard 74/75/76 camouflage with large blotches in 74/75 on the fuselage sides. The entire tail unit is Gelb 04, while the spinner is in the reverse order to that applied on operational aircraft i.e. white with a black spiral. This was a standard identity marking on Luftwaffe fighters in 1944. Both Balkenkreuz and swastika have white outlines but no thin black outlines*

115: *This Bf 109G fitted with an ETC 50VIId bomb rack was also in use at Orange and is finished in similar fashion to the Bloch 155 above. The RLM 74 and 75 blotches are softer but more densely applied. It seems that the undercarriage doors and legs are both finished in 76, the Electron wheel hubs are the standard RLM 66 or 22. While the propeller is the same white with a black spiral, it also has an RLM 70 baseplate and blades. The underside of the engine cowling is Gelb 04, while the rudder is Weiss 21*

116: *This Messerschmitt Bf 109F crashed as the result of a ground collision in Russia. 'Red 9' wears the standard 74/75/76 camouflage with a Gelb 04 fuselage band and the 'mid-war' style of Balkenkreuz and swastika*



117: *Left abandoned at Pardubice in Czechoslovakia, this Fw 190F-8/R1 was once in use with SG 77. Fitted with ETC 71 bomb racks, the very dull finish suggests that the underside is in a grey-green variant of RLM 76, while the uppersides are believed to be in RLM 81/82. The spinner is apparently finished in non-standard black with a very wide white spiral*

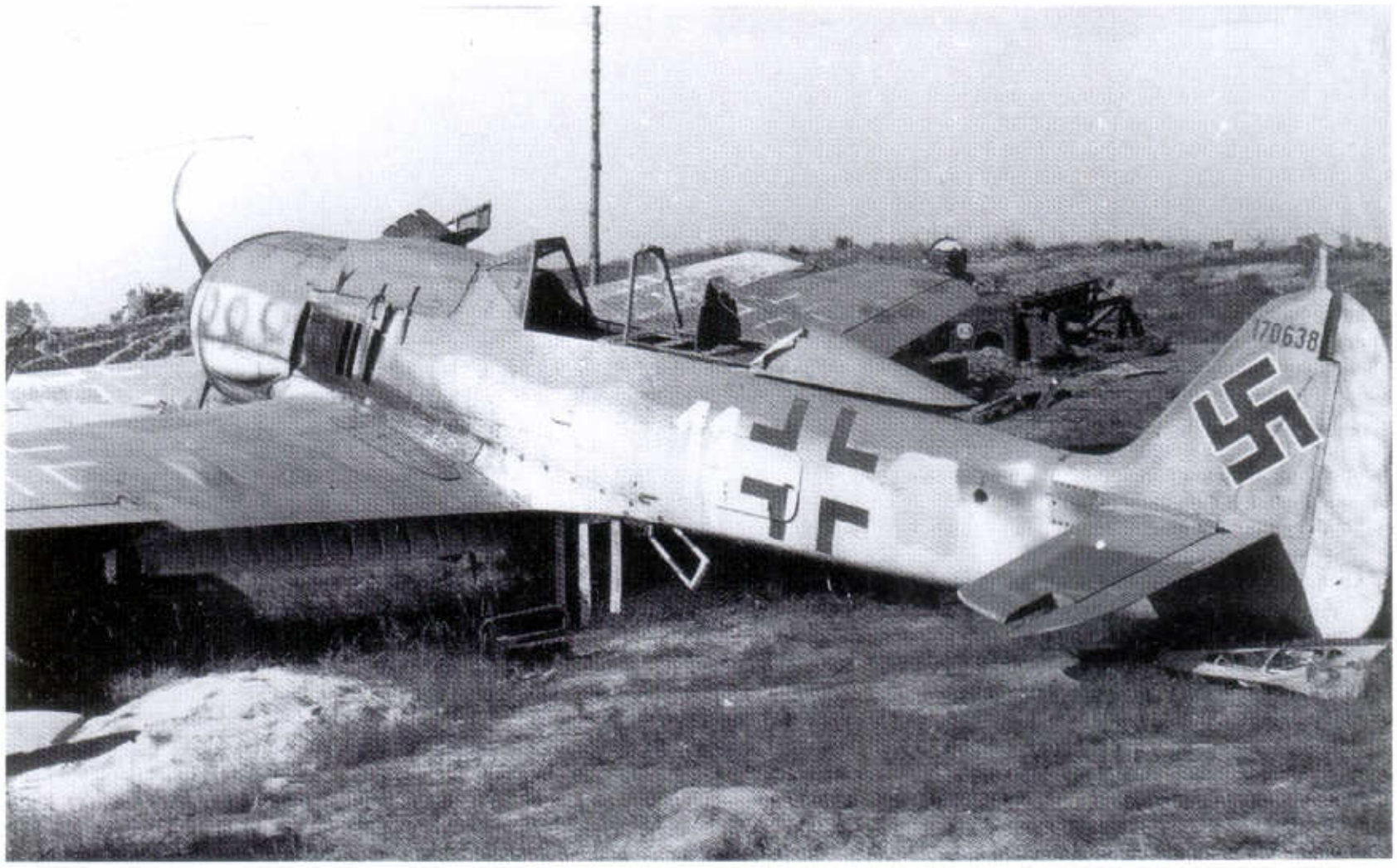
118: *Abandoned aircraft at Munich-Riem in May 1945. Nearest is a Wiener-Neustadt built Bf 109G-10, WNr 613165, 'Black 16', in Hungarian markings. Probably finished in RLM 75/83/76, the spinner and a ring around the cowling are in RLM 70. Immediately to the rear is another yellow ring. The Hungarian national insignia follow the requirements for simplification like those of the Luftwaffe. Further back, ex-Luftwaffe owned 'White 12' and red or green '19', WNr 613195, show further variations in national insignia. Both have yellow cowling bands*

119: *This Messerschmitt Bf 109 in RAF hands offers a classic view of the identification spiral applied to Luftwaffe fighters. Note, however, that the blade roots do not have the natural metal portion used to allow checking for blade alignment, but are overall RLM 70*

120: *Pilots in front of a Bf 109G-6, finished in 74/75/76 with all markings of the maximum simplified type. i.e. with just the white angles only and the centres filled with the dark camouflage colour. (See page 155). Note where the paint has eroded from the propeller blade tips and the small white '14' on the cowling, which suggests that the aircraft is in use as an advanced trainer*

121: *Bf 109G-10 WNr 770313, 'Black 3', seen at Berlin-Gatow post-war, gives a good view of the different colours of the propeller blades (RLM 70) and the black spinner. The difference in the hues is clearly visible. Is the dark coloured area directly behind the spinner red, RLM 70 or simply an oxidized natural aluminium replacement part? It is also just possible that the cowling ring is 04, looking dark on account of the film type used. The photo also offers a very good view of the faded RLM 75, not far away from the white of the propeller spinner*

122: *Another view of Bf 109G-10, WNr 770313, 'Black 3', shows it to have the large tyres and upper wing bulges. Also visible is the aerodynamically refined cowling for the DB 605D engine. On the leading edge of the wing is a 'saw tooth' colour demarcation line. The swastika is the late war maximum simplified type in black only, while the under wing Balkenkreuz is the medium simplified type with inner black cross. The visible parts of the fuselage Balkenkreuz appear to be the maximum simplified type with white angles and an inner cross in RLM 83. Although weathered, the camouflage is probably 75/83/76, the 75 weathered to a very light grey (compare this with the parts of the wing on the ground). Note the Cyrillic graffiti*



123: *An Fw 190 A-8, WNr 170638, 'White 11', abandoned at Berlin-Gatow in early 1946 with an old style canopy and a mix of maximum simplified Balkenkreuz and a medium simplified swastika. The aircraft was painted in 74/75/76 and had large repainted areas around the fuselage cross where an earlier identity had been. It appears that the tail unit may be a replacement as the camouflage pattern does not match that on the fuselage spine. The lowered flap can be seen to have been left unpainted on the inside in accordance with industry instructions*

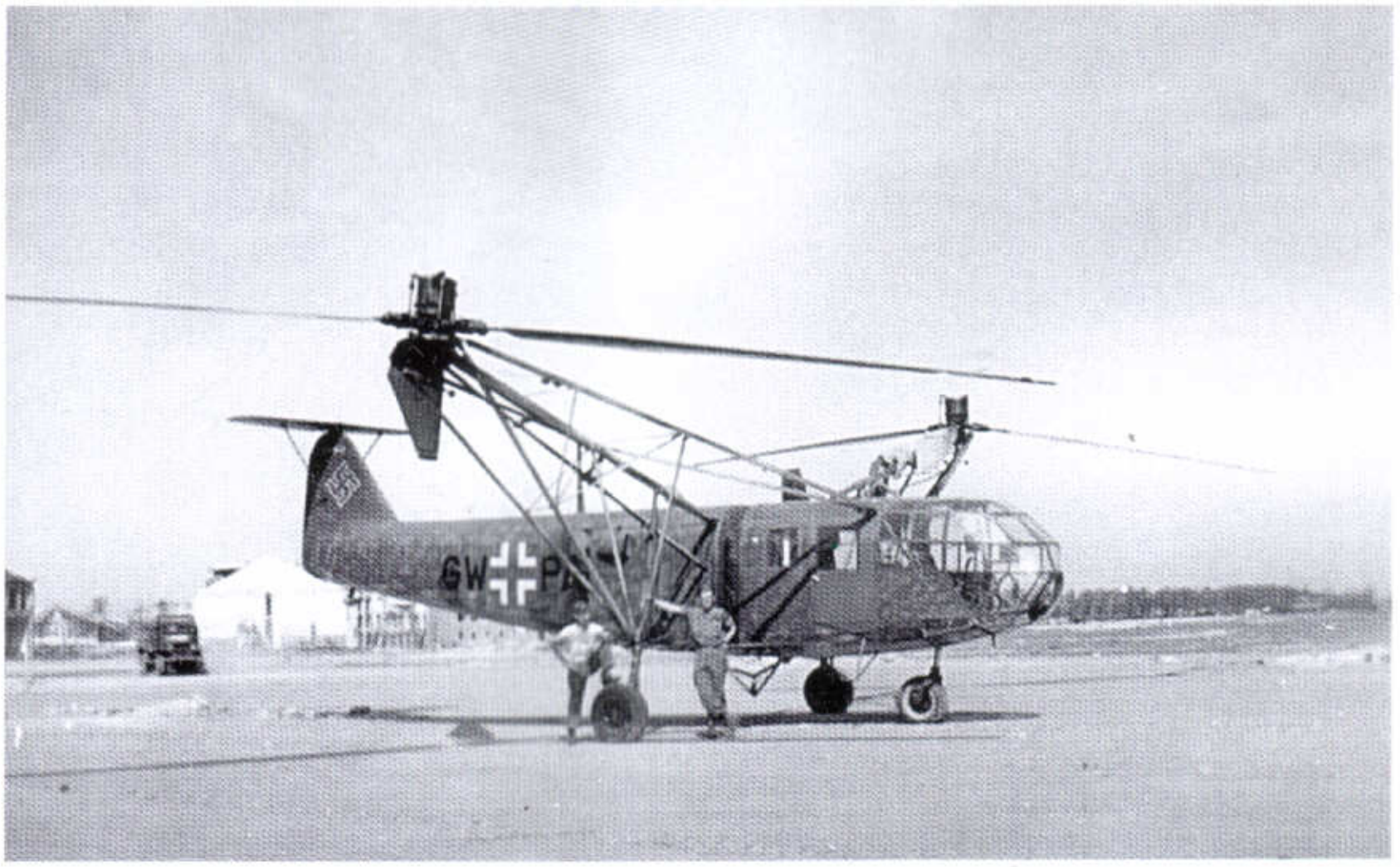
124: *This Fw 190D, WNr 211164, 'Black chevron 4' was abandoned at Prague-Ruzyne at the end of the war. Once of the Stab of JG 2 or JG 6, it exhibits a variety of finishes. The fuselage sides appear to be a very pale version of RLM 76, with what may be RLM 82 on top of the engine cowling. The dark tone of the undercarriage fairing suggests that it is in weathered unpainted metal, as was demanded on aircraft produced late in the war. (See page 183). Note that the maintenance instructions have still been applied to the leg fairing. National markings are strictly as the regulations*

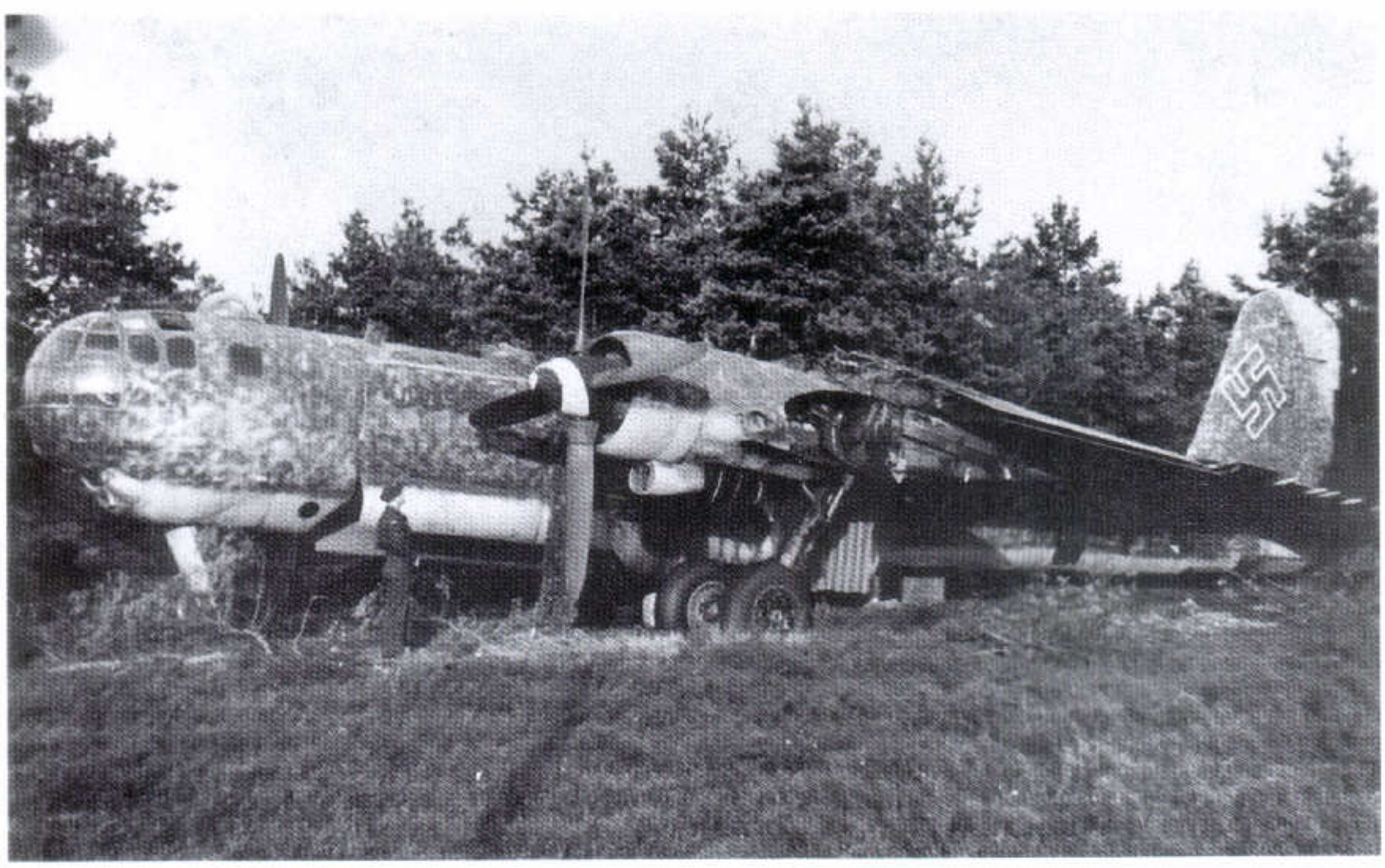
125: *This Blohm and Voss Bv 141B is something of a mystery as only five of this type were supposed to have been produced but as far as is known, none bore the code GK+GH. Painted RLM 02 overall, the aircraft wore the mid-war type of national insignia when it was found abandoned at the Blohm and Voss works at Wenzendorf in May 1945. The simple camouflage could indicate that it was either left over from a training school or was being refurbished for operational use*

126: *A row of Me 410s of Seenotgruppe 80 on the island of Westerland-Sylt in May 1945, each rendered unflyable by the removal of a portion of the rudder. All four aircraft are finished in the RLM 74/75/76 camouflage as per the OS List drawing (see page 20). All the visible swastikas are of the 'mid-war' style in black with a white border. Balkenkreuz have the centre filled in with RLM 74. WNr 41010016 is unusually long, having eight digits. Note the two kill markings on the rudder*

127: *The Junkers Ju 388L-1/V6, WNr 500006, PE+IF, seen at Farnborough in 1945. Originally white in accordance with official requirements, the national markings were overpainted by the new owners. A splinter camouflage pattern is clearly visible and was probably RLM 70/71, with undersides in 76, as on the earlier Ju 188. It is possible, however, that the lighter tone was RLM 82 Hellgrün. Note the small white '6' on the rudder indicating that this was the sixth prototype. The aircraft handbook, dated 25 January 1945, makes no mention of camouflage*

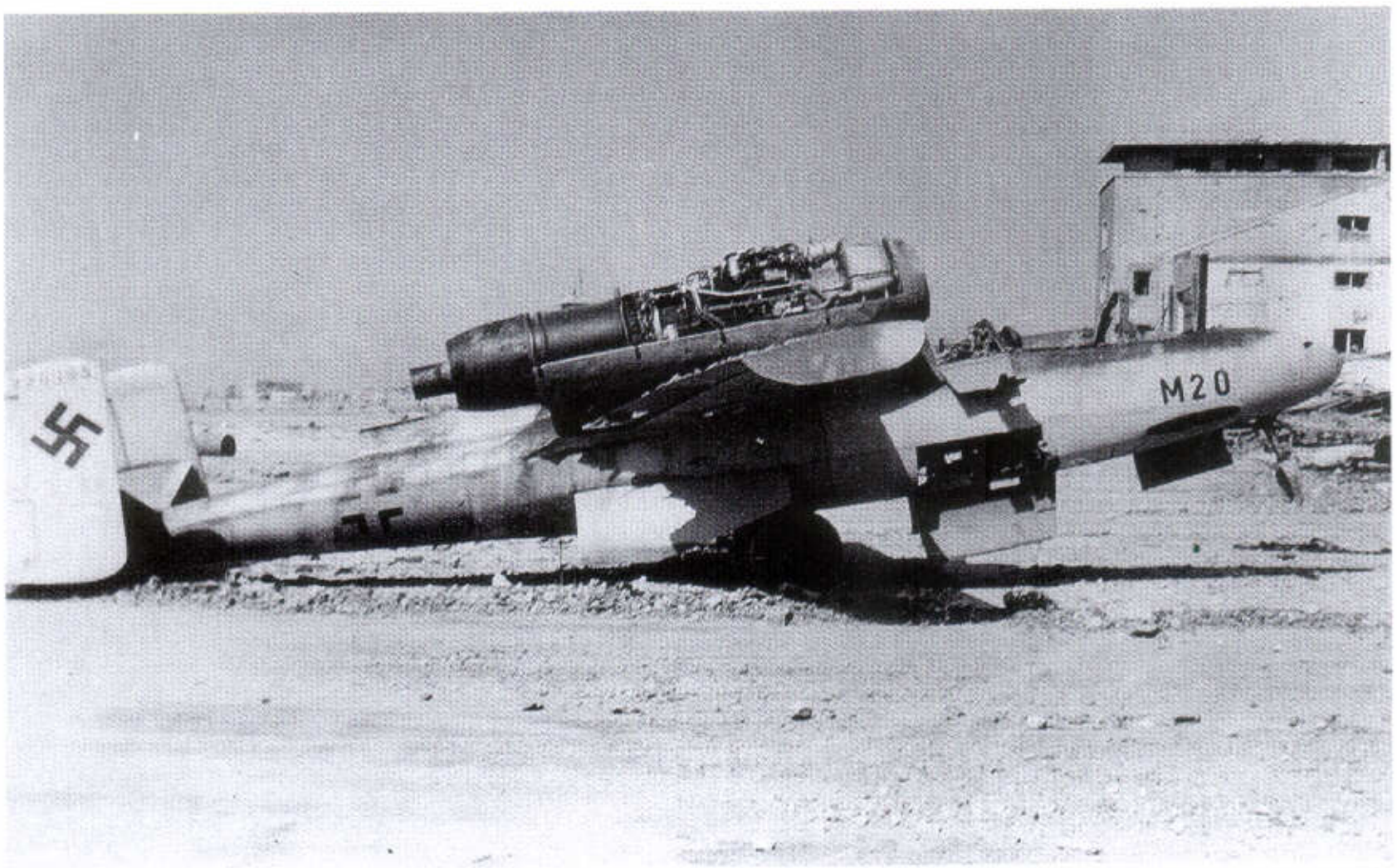
128: *This is the only Focke Achgelis Fa 223E, GW+PA, WNr 0051, in American hands in May 1945. Compared to the black of the code letters, the camouflage appears too light to be 70 or 71. It could be a dense meandering squiggle of RLM 82 over an RLM 76 or RLM 02 base. Swastika and Balkenkreuz are white in the maximum simplified style in accordance with regulations*





129: *Quite what colours this wrecked Heinkel He 177 found at Fassberg was finished in is hard to say. The undersides were a very pale tone, which should have been 65. The uppersurfaces seem to be in the two original greens with a fine scribble of a light grey over the top which in turn has been touched up with a dark green. At some point a triangle of a light tone was applied to the rudder which has then also been 'scribbled' over. The swastika is just a white outline and the spinner was black with a white spiral*

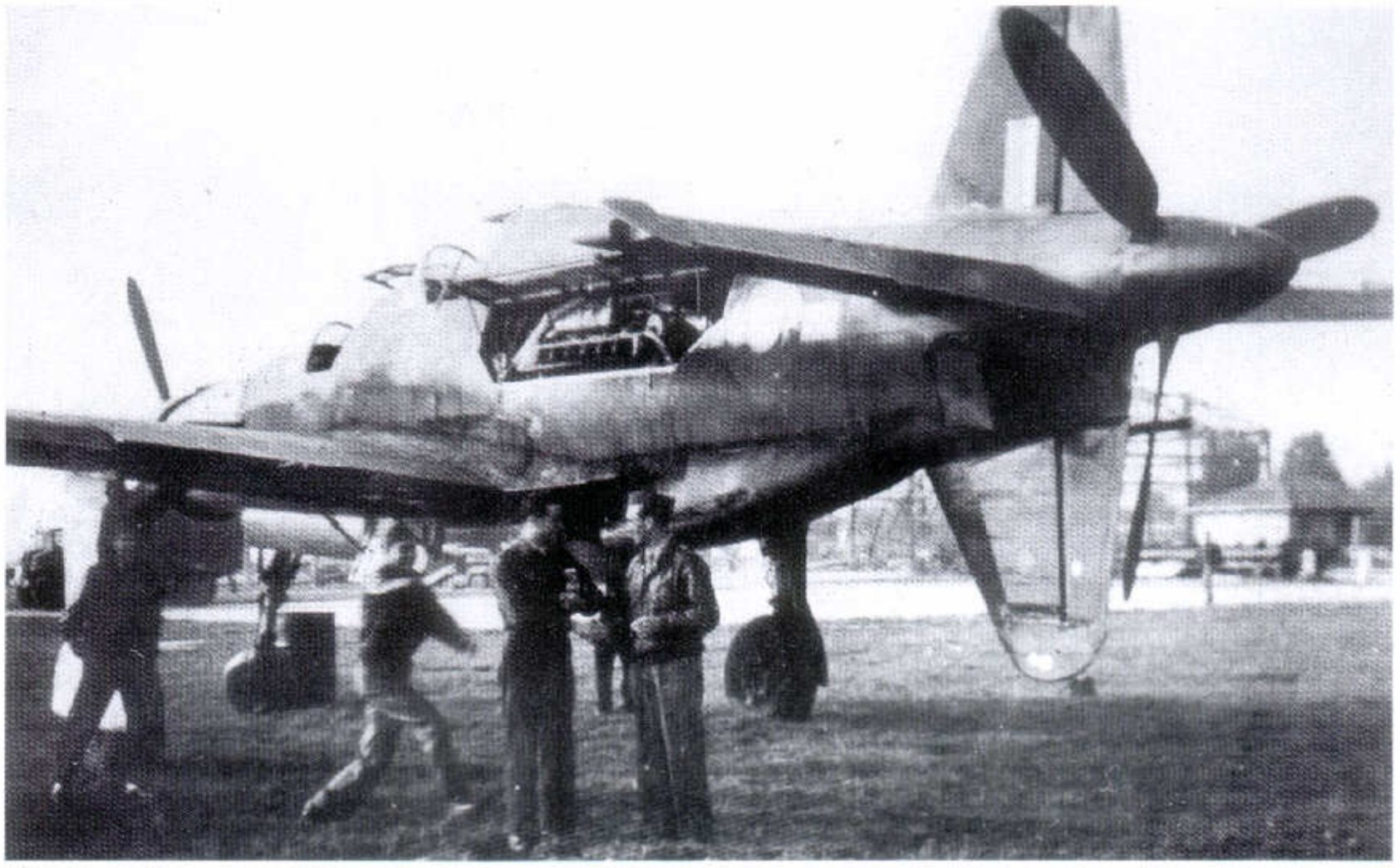
130: *As the war progressed many unusual aircraft were press-ganged into Luftwaffe service, among them this Fiat CR 42 used for training. Camouflage on 'Black 86' is RLM 71 with 02 blotches and an 04 Gelb band. The national markings are of the late-war maximum simplified type. Note that the wheel fairings have been removed to simplify maintenance*



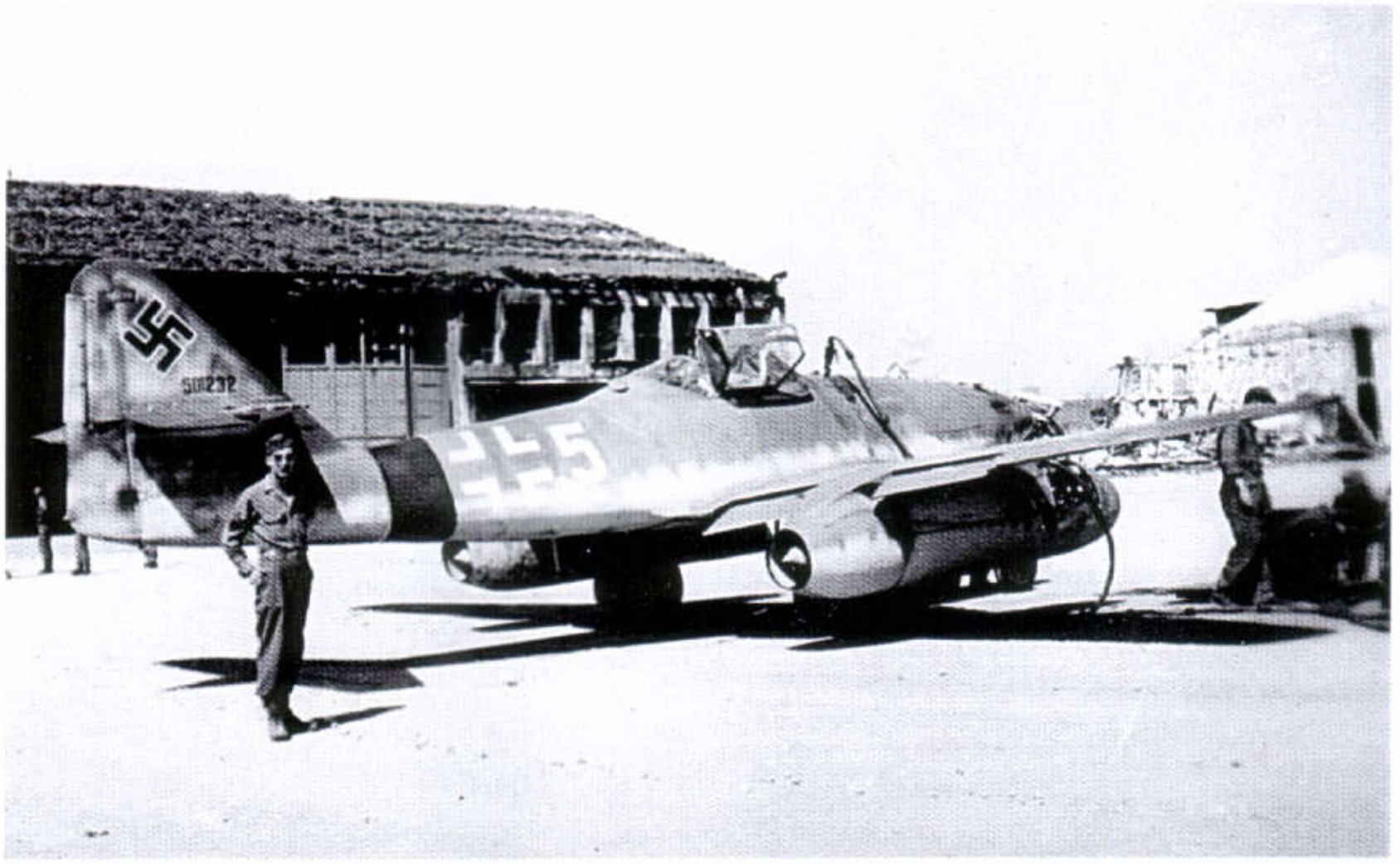
131: *This wrecked Heinkel He 162 prototype, M20, WNr 220003, was fitted with a simplified undercarriage. It first flew on 10 February 1945 but was damaged only 15 days later. It is seen here in May 1945 at Munich-Reim, after being pulled out of a wrecked hangar for photography. The colour scheme appears to be RLM 81/82/76 in accordance with the factory documentation*

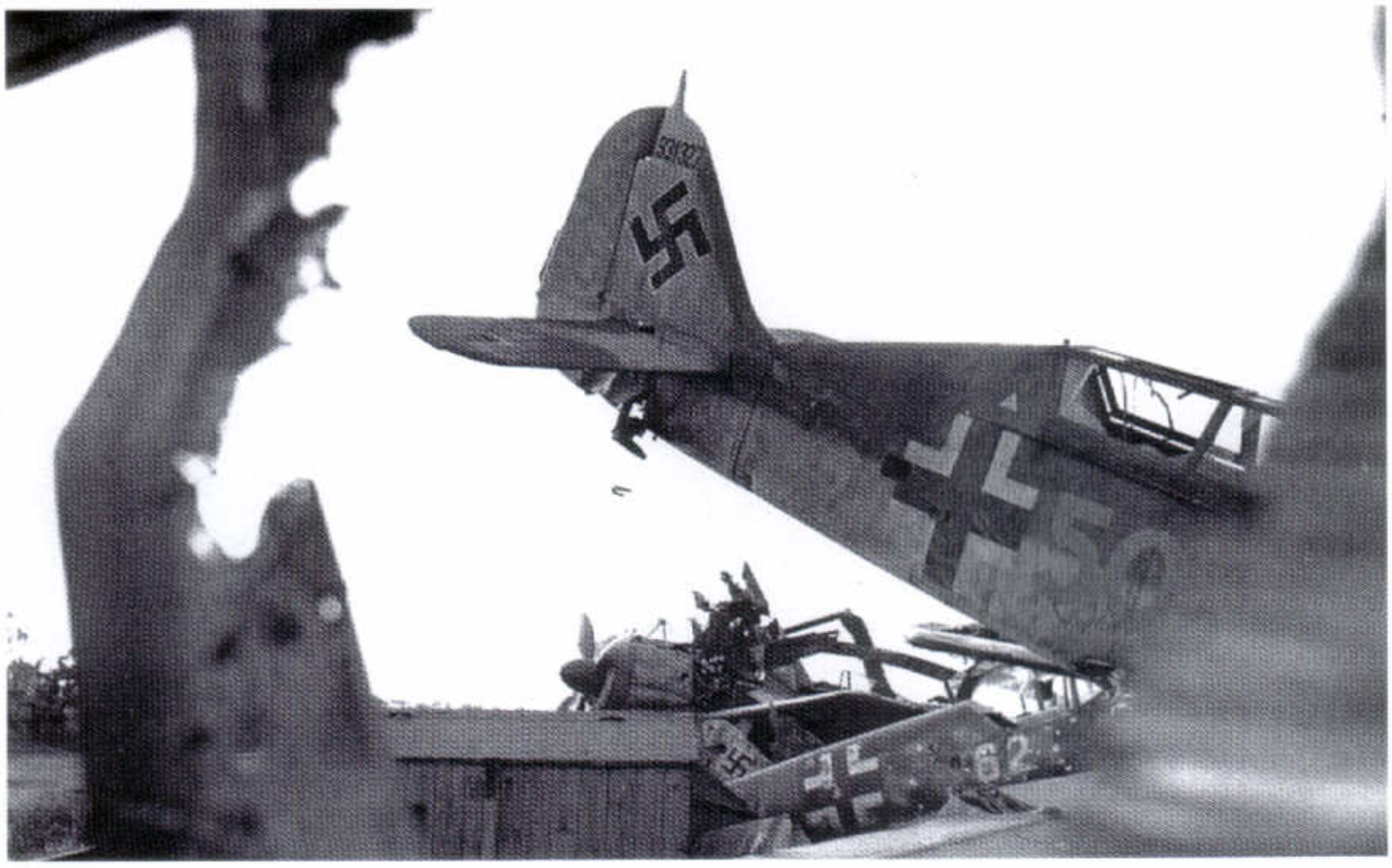
132: *Sitting in front of He 162 M20 at Munich-Reim is the M23, WNr 220006, VI+IP, which had modified wing roots. The colour of the wheel hub and the aircraft is the same. Possibly this was a green primer, one of the late war 81 or 82 tones or even dirty 02. The tail assembly appears to be a slightly lighter colour than the rest of the airframe, possibly RLM 76. M23 also has an incorrect style of Balkenkreuz, with only the black inner cross. The swastika is the simplified black style intended for use on the bright colours 65 or 76. The Werk nummer was painted twice, again extremely unusual*

133: *Seen during its transit to the UK, this is the Dornier Do 335A-12 trainer, WNr 240112, RP+UB, with the original German insignia painted out but still in its original camouflage. The forward 'power egg' remains in unpainted metal finish, while the rest of the uppersurface was in RLM 81 and 82. (See page 191) Note where the original swastika has been painted over and the dark tone of the Schwarzgrün 70 spinner compared to the RLM 81 adjacent to it. The aircraft later crashed in England during a test flight from Farnborough on 18 January 1946, killing its pilot*

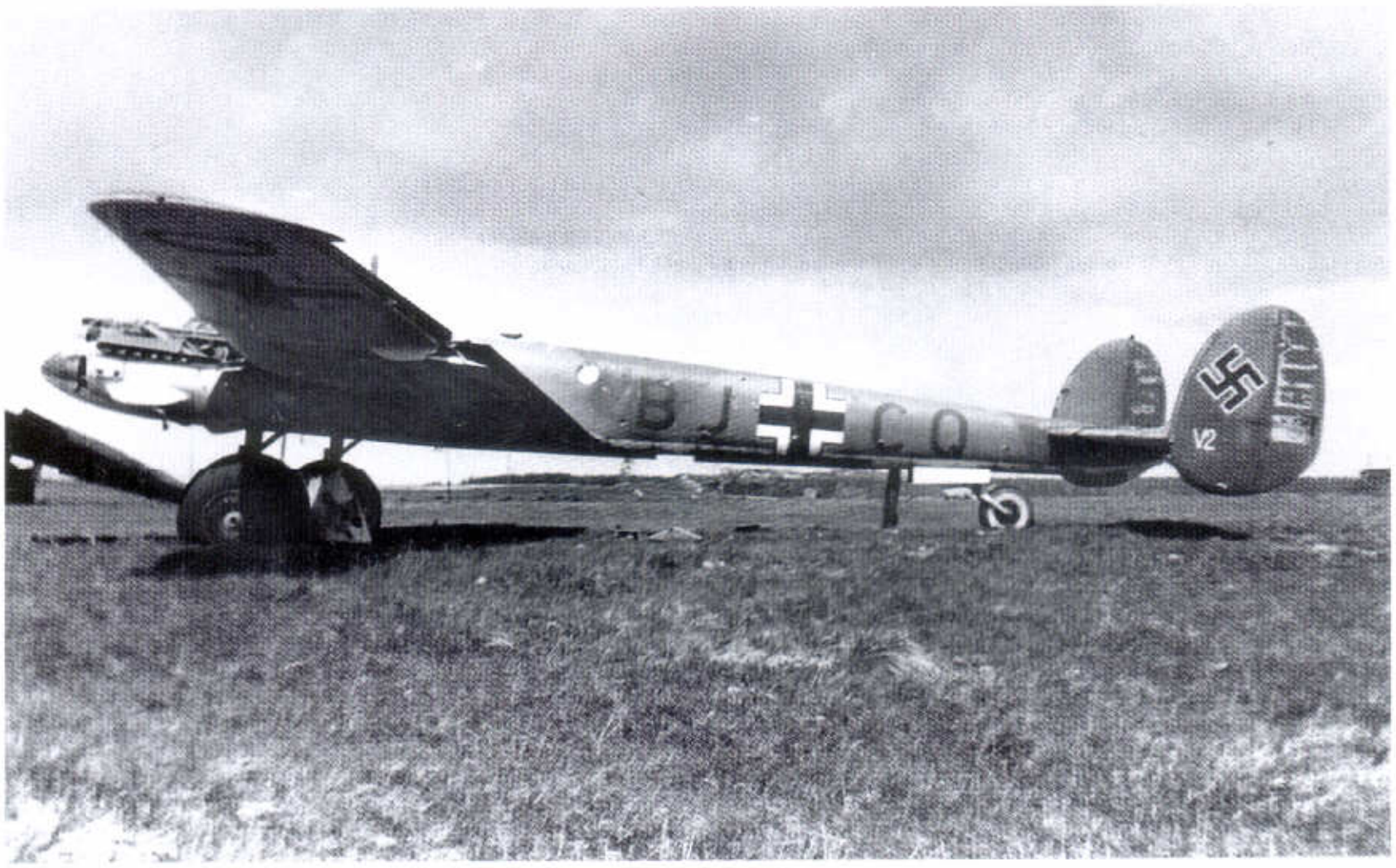


134: *Another of the jets captured at Munich-Reim was Me 262A-1a, 'Yellow 5', WNr 501232, believed to have once served with KG(J) 6, as indicated by the red/black(?) bands. The camouflage pattern is probably the later scheme of 81/82/76. Although the Balkenkreuz is the standard late war type, the swastika still retains a white outline. The aircraft still survives in the USA*



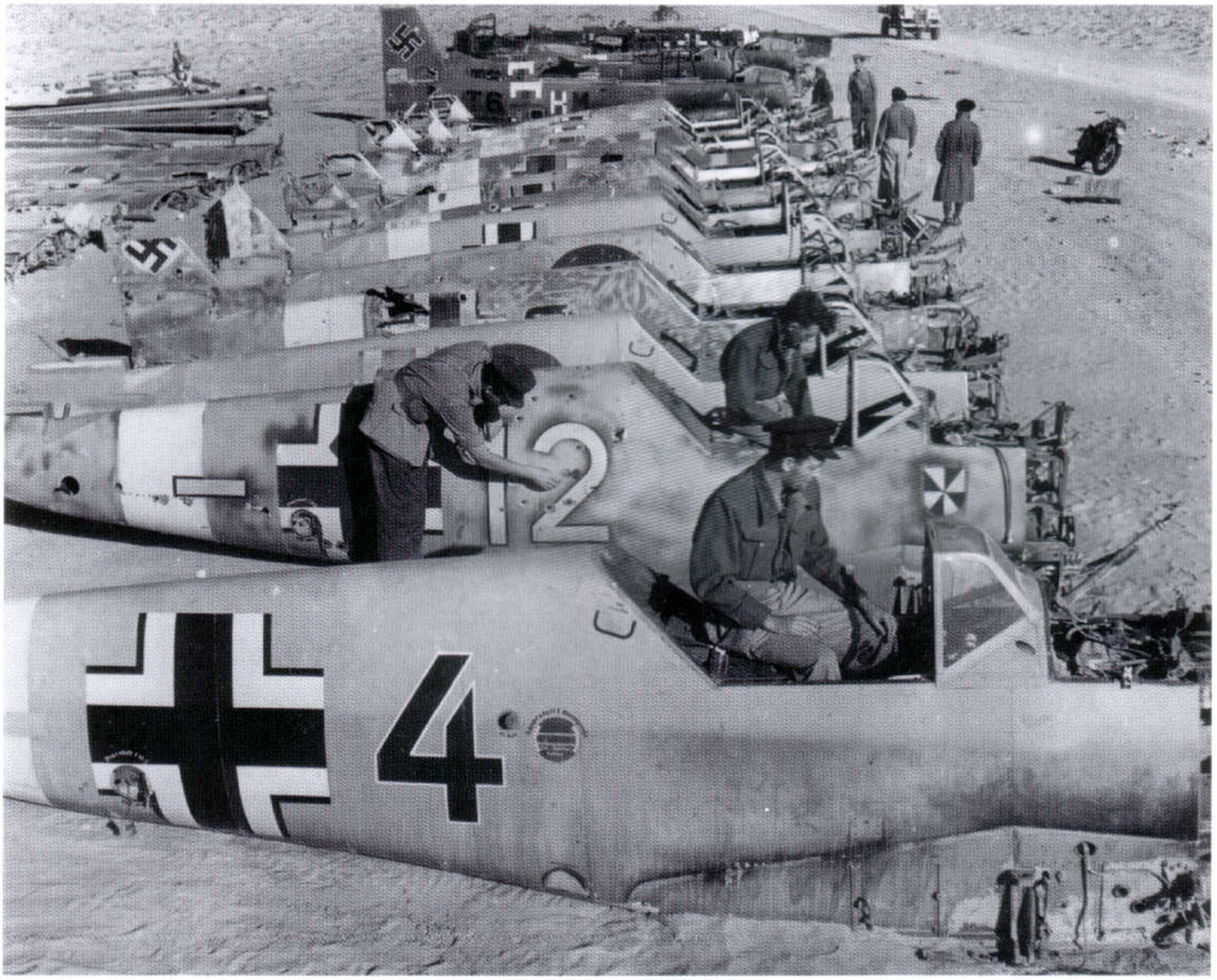


135: *This abandoned Fw 190S-8 trainer, 'Red (or yellow) 50', WNr 931327 appears too dark for a 74/75/76 camouflage. It could be that the fuselage spine is overall 74 or possibly 83 with mid-war period national markings. The werk nummer comes from the 93xxxx series, used by Fw 190F-8 models, which would be an unusual basis for the two-seat conversion*



136: *The wreck of the Messerschmitt Me 261 V2, BJ+CQ, abandoned at Lechfeld in 1945. The aircraft had been there for some time as the 70/71 camouflage had washed out revealing the primer (compare with the description of Fliegerlackkette 20 on page 222). Both Balkenkreuz and swastika have a thin black border*

137 Below: *Arado Ar 234B-2 WNr 140173, F1+MT, of 9./KG 76 wears 81/82/76 camouflage with a wash of temporary white or light grey as snow camouflage. The aircraft was shot down on 22 February 1945*



TROPICAL COLOURS

Operations in North Africa and the Mediterranean area made quite new and unexpected demands on camouflage for Luftwaffe aircraft. Initially, aircraft in the theatre were received painted with the European-style grey or green camouflage. These colours were soon discovered to be quite unsuitable in the desert environment. To overcome these early difficulties in the short term, resort was undoubtedly made to the camouflage paints that Germany's Italian allies used.

Unfortunately for students today, the *Regia Aeronautica* was using a wide range of camouflage colours, many of closely similar shades. Since the re-painting of Luftwaffe aircraft was made in the field with colours provided by the Italians, it is impossible to say precisely what colours were used. The following is a complete list of relevant colours used by the Italians:

Shade	Italian Name
Yellow	Giallo Mimetico 1
	Giallo Mimetico 2
	Giallo Mimetico 3
	Giallo Mimetico 4
	Nocciola Chiaro 4
Grey	Grigio Azzuro Chiaro 1
	Grigio Azzuro Scuro 3
	Grigio Mimetico
Green	Verde Mimetico 1
	Verde Mimetico 2
	Verde Mimetico 3
	Verde Mimetico 53192
	Verde Olivia Scuro 2

The following colours were introduced by the RLM to eliminate the shortcomings:

138 Above: *There are twelve Messerschmitt Bf 109 fuselages in this picture taken on the road to Gambut. 'Yellow 12' of II./JG 3 appears to have had an overspray of RLM 79 or an Italian sand colour over the original camouflage, while 'Red 4' in the foreground has had a solid top colour of RLM 79 applied at the factory. Further back WNr 4159 has had streaks applied by brush. All wear the standard mid-war style of Balkenkreuz, except for one aircraft carrying crudely applied RAF markings. Note that the Ju 87s of StG 2 still wear RLM 70/71 European camouflage*

RLM 78	Himmelblau	Sky blue
RLM 79	Sandgelb	Sand yellow
RLM 80	Olivgrün	Olive green

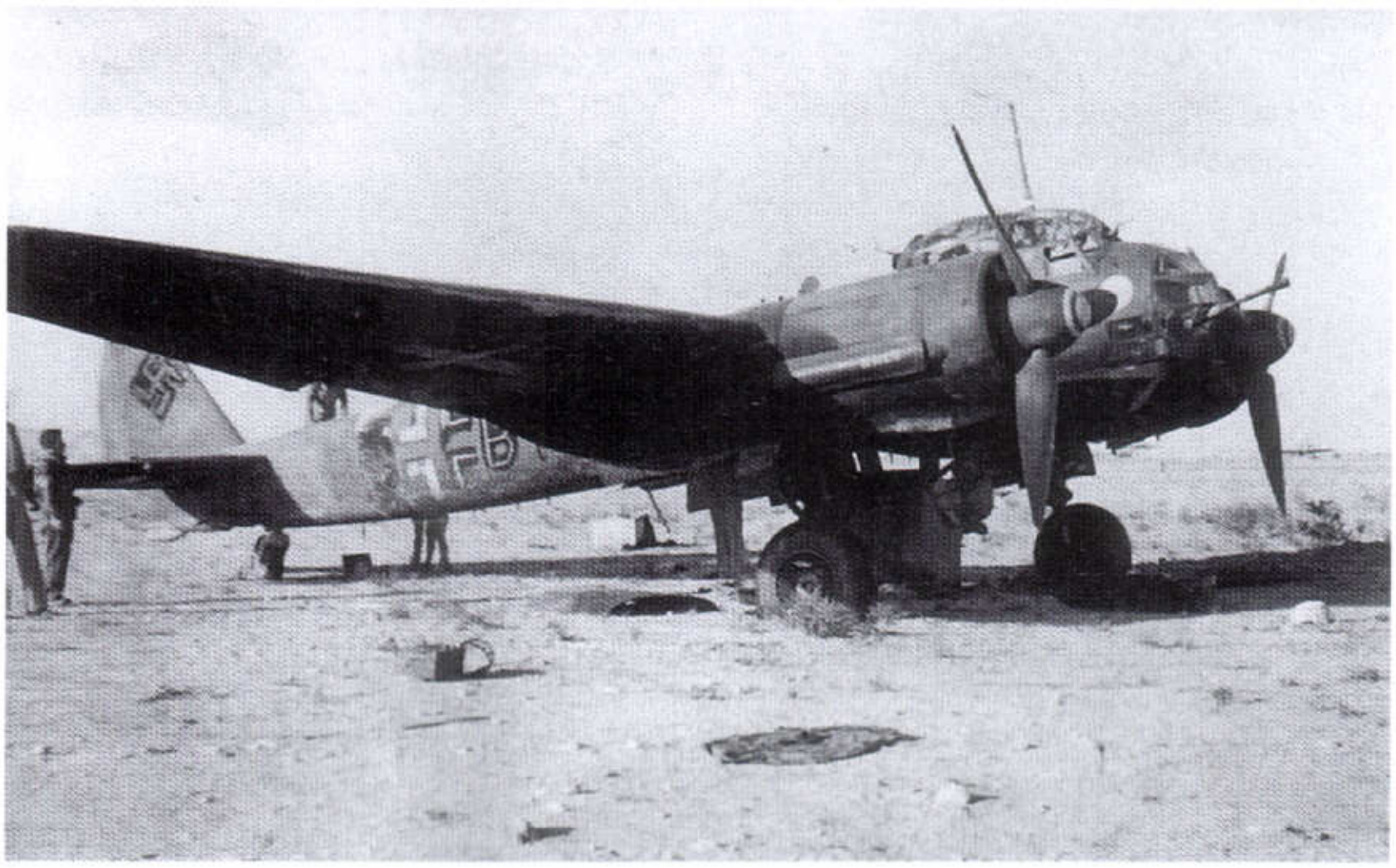
Photographic evidence suggests that only a few types were actually factory-finished in the tropical camouflage; predominant among these were the Messerschmitt Bf 109F and early G models and a few Bf 110s. Generally speaking, it seems that these colours were mostly used to convert existing aircraft camouflage in the field. Many aircraft, in fact, never received desert camouflage. Most Junkers 87s in the theatre, for example, seem to have soldiered on in their usual green paint throughout their operational lives. Aircraft allocated for this area of operations, however, were provided with tropical equipment by the manufacturer and, like naval aircraft, were heavily protected against corrosion.

139 Right: *This Focke-Wulf Fw 190F or G of I/SG 4 in Italy was probably painted in the field in RLM 79/80. The undersides could have been repainted but were more likely left in the original RLM 76. The remnants of a girl's name can be made out on the cowling*

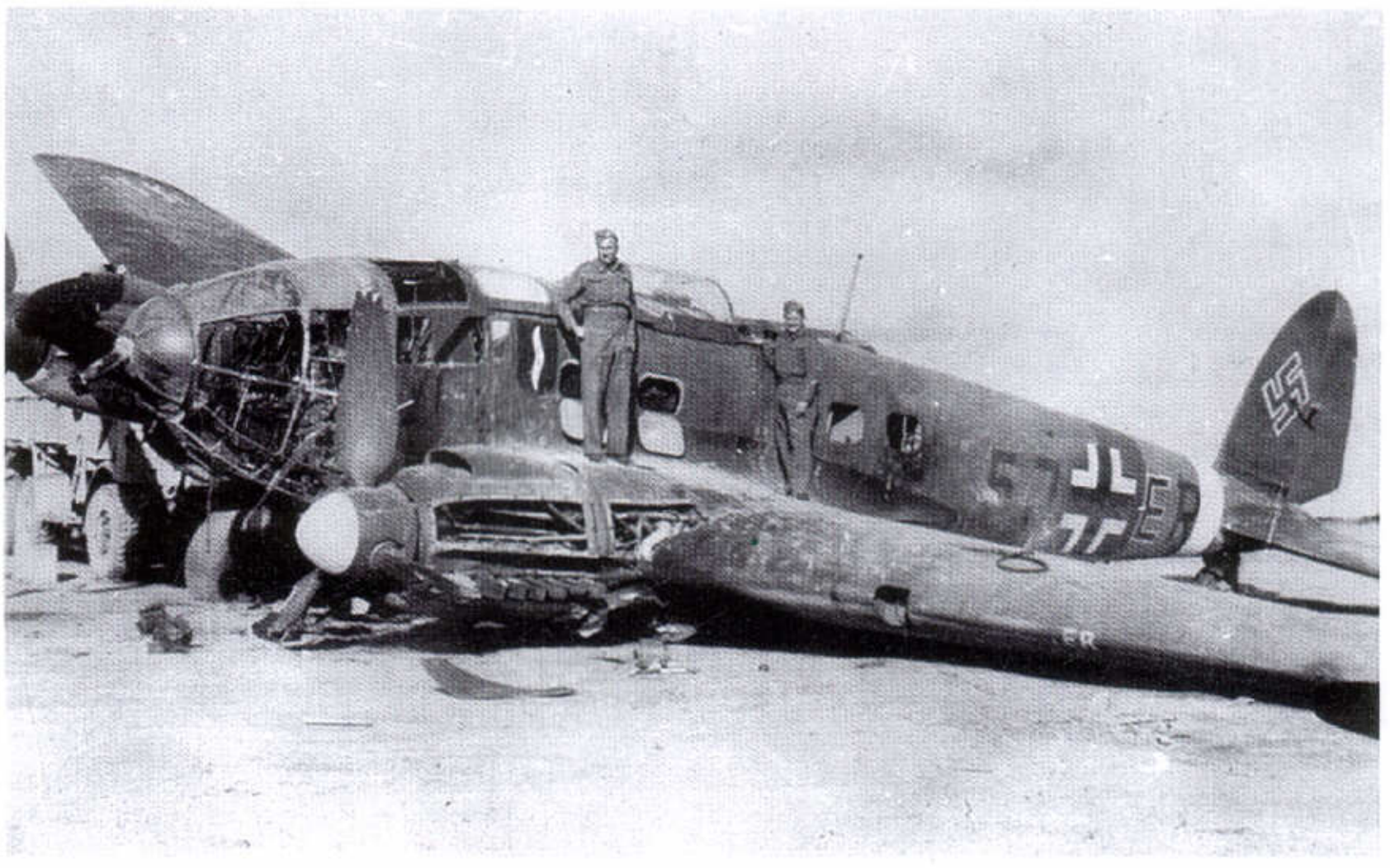
140 Below: *Damaged Bf 109G-2 or G-4 Trop fighters of JG 53 at an outdoor repair depot in Sicily in 1942. Both 'Red 7' of 5 Staffel and 'White 10' of 4 Staffel wear factory-applied RLM 78/79 camouflage with white theatre markings. The Bf 110 is almost certainly from ZG26 as part of that unit's '3U' code can be seen. It is probably still in a factory RLM 74/75/76 finish apart from the very strangely marked starboard rudder. Note the contrast with the dark green Ju 52 in the background. All three near aircraft wear the typical Messerschmitt mid-war fuselage Balkenkreuz, without the thin black outlines*

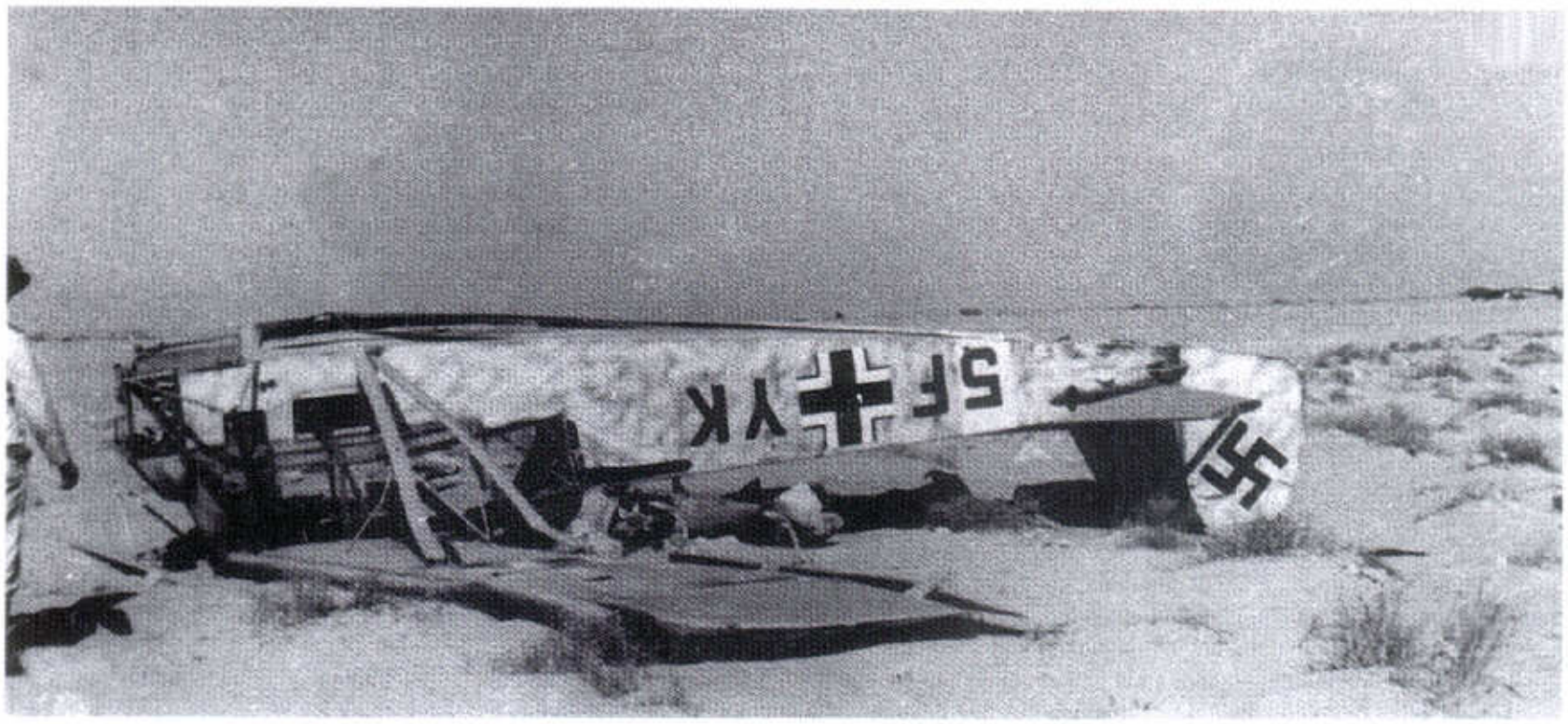
141: *Messerschmitt Bf 109E-4, white '6' of 7./JG 27. The placing of the aircraft number on the engine cowling was a distinctive practice by III Gruppe, originating in France during the Battle of Britain. Apart from the temporary yellow engine cowling and rudder and white fuselage theatre band, the aircraft appears to have retained its European 74/75/76 camouflage. The spinner appears to be white with a black tip. Note how the underside colour has been brought up over the wing leading edges and the Gruppe emblem under the cockpit canopy. Gela, Sicily, May 1941*

142: *A Ju 88A-4 (or the tropical A-11 variant?) in a very faded 70/71/22 paint job for night missions. This is indicated by the engine exhaust flame dampers, the starboard outer carrying a small white four-letter legend, possibly a transit code. All markings, including a white fuselage band, have been toned down with temporary black paint (also on the underside) which is being cleaned off, revealing the fuselage Balkenkreuz to be of the maximum simplified type. Tips of the spinners have white rings, probably indicating the staffel. Note the 20mm nose cannon with a flash suppressor*



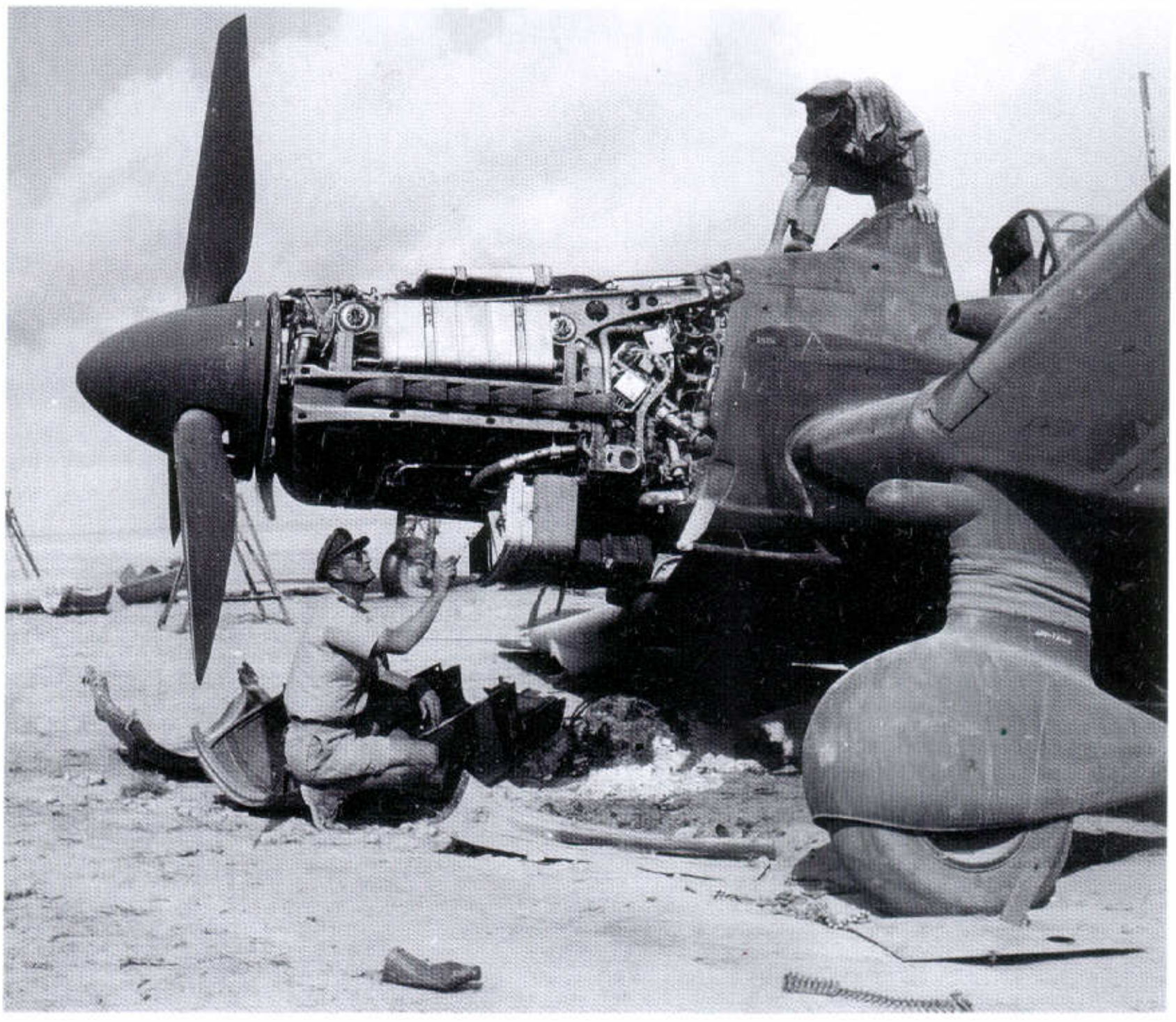
143: *An abandoned He 111 of 7./KG 4, somewhere in the Western Desert. Finished in very dusty 70/71/65, 5J+ER, has what appears to be a Gelb 04 and a Weiss 21 fuselage band. Codes and national markings are standard for the mid-war period. The propeller spinners are white and the individual aircraft letter, 'E', is outlined the same colour, both indicating the staffel. Note the last two letters of the code on the wing leading edge in white to allow ground crew to identify their charge on darkened airfields*





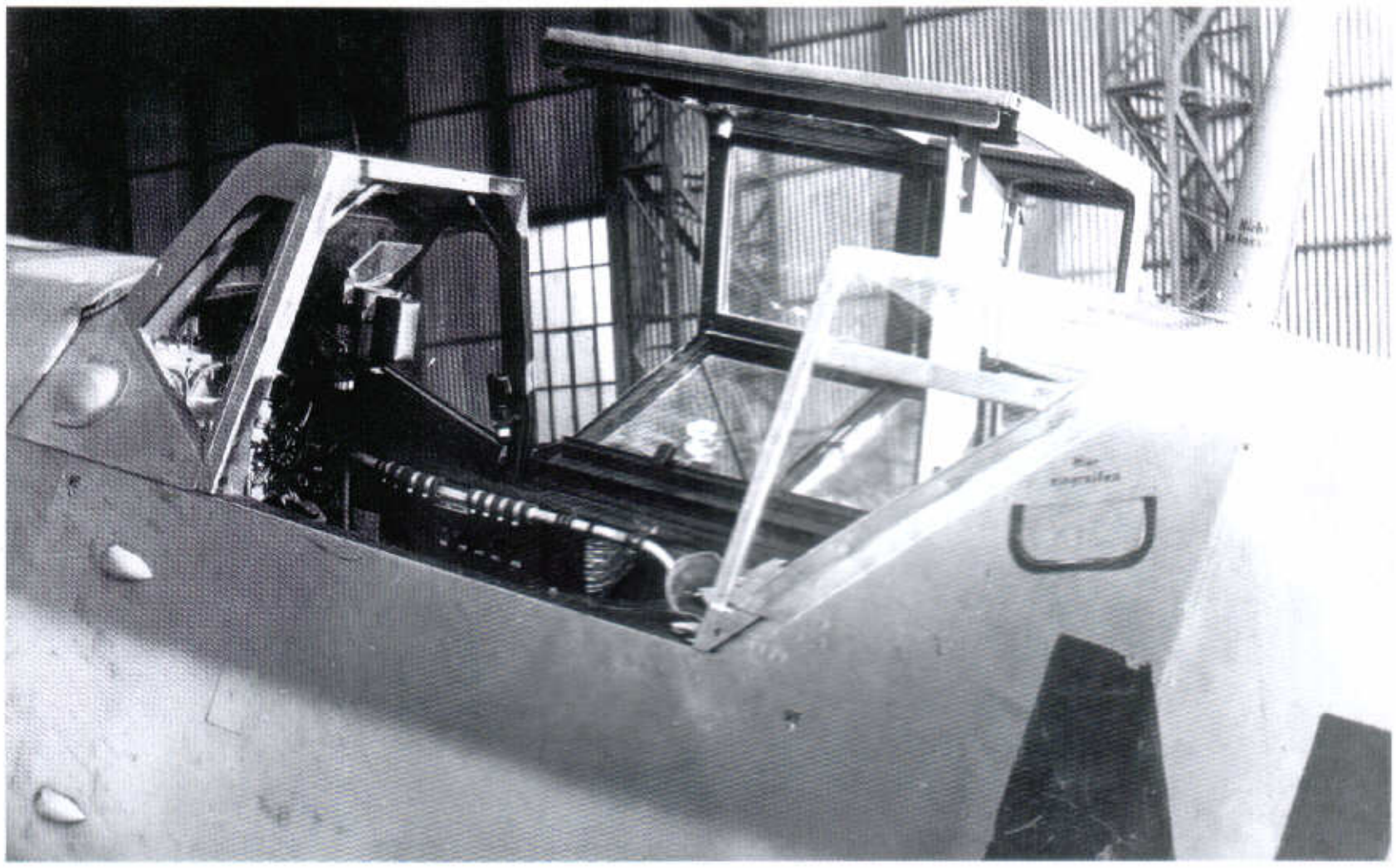
144: *This wrecked Fieseler Fi 156C-3/trop of 2.(H)/ Aufkl.Gr.14 lies abandoned somewhere in North Africa in 1942. The camouflage scheme seems to consist of a very dense mottle of a light sand colour, possibly of Italian origin, over the original 70/71, while the relatively dark tone of the underside may indicate RLM 78. Note the excessively large swastika on the rudder, the usual location on a Storch*

145: *A Junkers Ju 87R, still wearing the delivery code KP+MP and the uncommon tropical camouflage scheme of overall sand 79 with large green 80 patches. The aircraft had an 'old' style swastika and Balkenkreuz with thin black borders. An interesting detail is that the spinner and front face of the propeller blades seem to be painted in RLM 79. The distinctive pitot head on the aircraft wing in the foreground belongs to a Junkers Ju 52/3m*

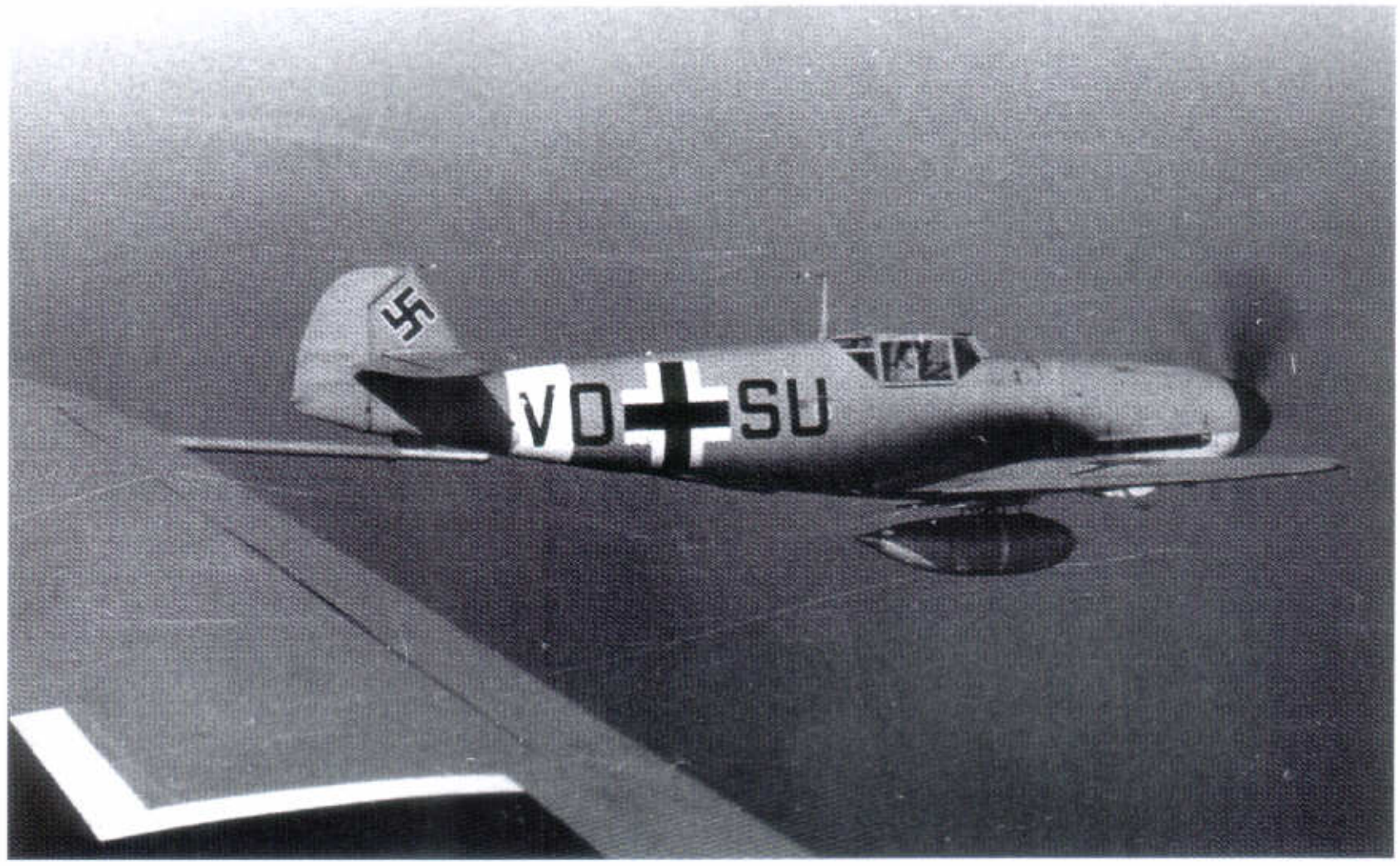


146: *Gambut, December 1942. RAF intelligence officers examine the remains of a Ju 87D, possibly ex-St.G 2, in the desert sun which has caused much fading of the European 70/71 camouflage. This has been touched up above the wing root, possibly in RLM 70, as this area matches the tone of the propeller*

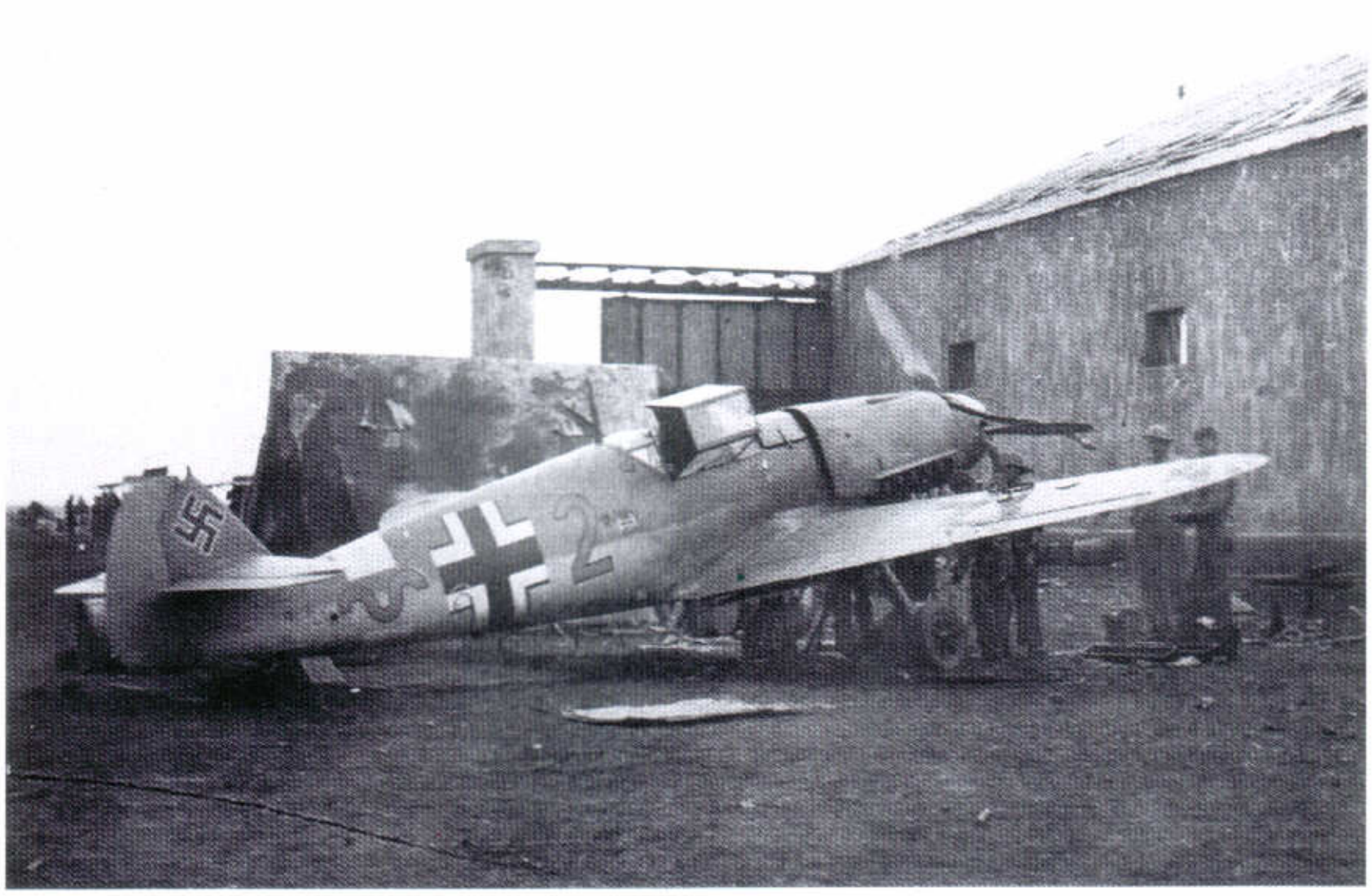
147: *A detailed closeup of the cockpit of a Bf 109G-4 trop clearly showing the factory finish of RLM 79/80, the cockpit interior finished in RLM 66 and various stencil details. There is apparently an unusually placed white fuselage band. Also worthy of note are the two teardrop fairings which served as holders for a sunshade and the crudely applied Stammkenzeichen in washable black paint*



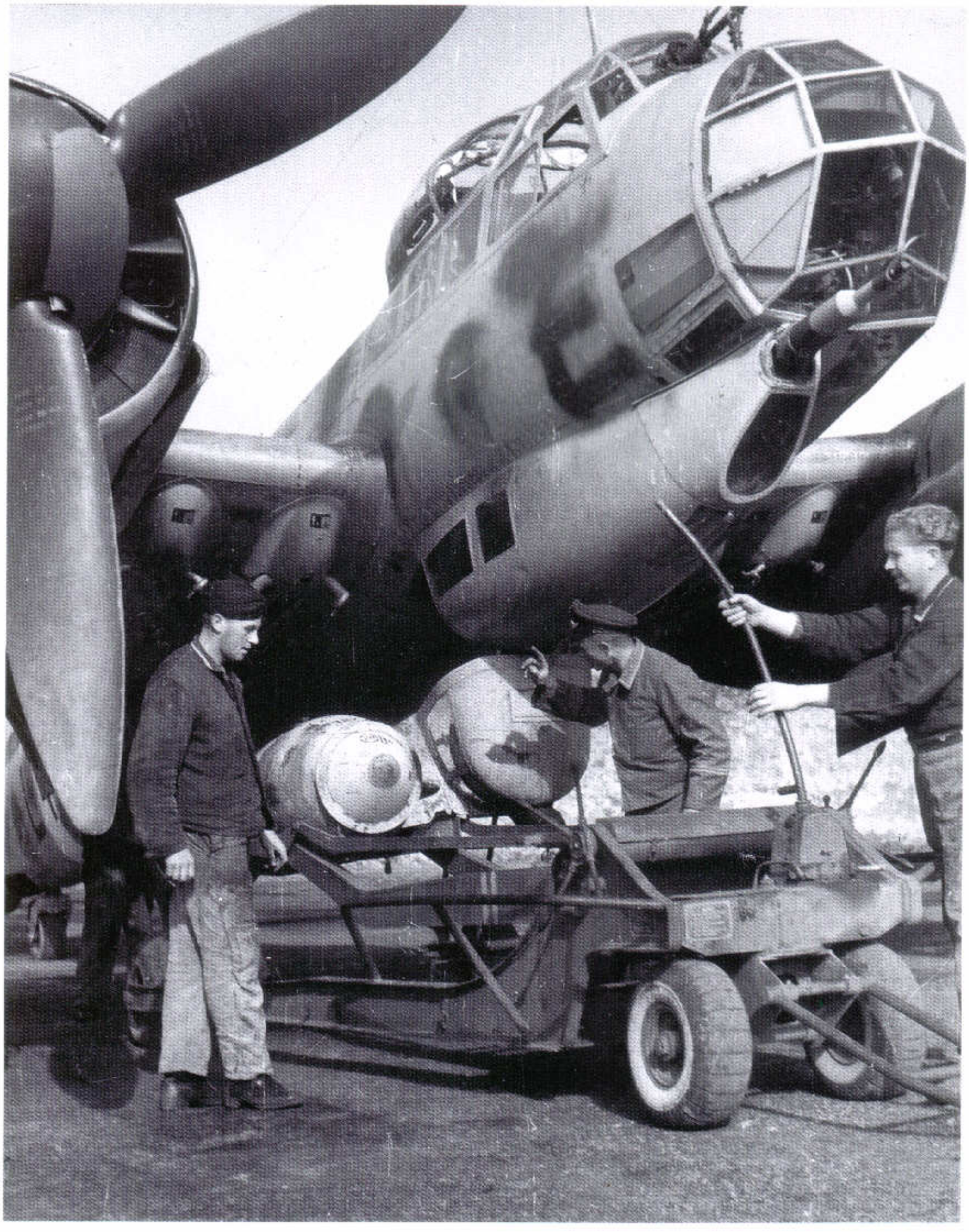
148: *A Bf 109F-4 Trop reconnaissance version (note lens fairing below fuselage), probably on a delivery flight over the Mediterranean. It is finished in a factory-applied 78/79 camouflage scheme with a white fuselage theatre band and a yellow underside to the engine cowling. The spinner remains in RLM 70. The delivery code, VO+SU, applied in temporary black is already wearing off.*



149: *A Messerschmitt Bf 109F with Sandgelb 79 uppersurfaces and Hellblau 78 below; the typical desert camouflage. The white band on the rear fuselage indicating the Southern Front is clearly visible. The rudder bears a noticeably lighter paint than the 79 of the fuselage and is probably RLM 04 Gelb as it closely matches the number '2' and the III Gruppe wavy bar*



150: *A Messerschmitt Bf 109, 'Black 13', having its national markings changed by South African personnel. This may be the Bf 109F trop which was captured by No. 4 Squadron SAAF at LG12 in late December 1942. It appears to wear the unusual 'saw-tooth' edged 74/75 camouflage pattern applied to a number of the reconnaissance variants of the Bf 109*



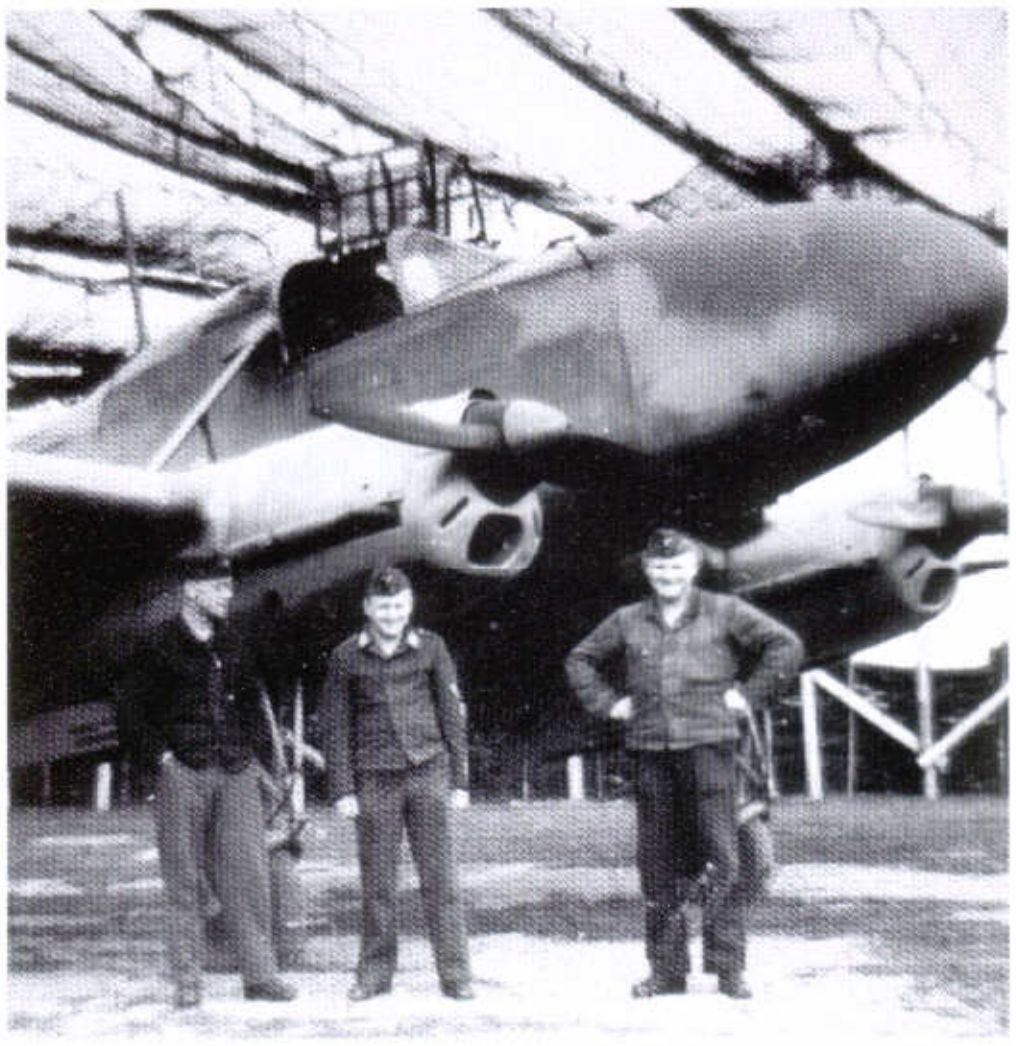
151: *A Ju 88A-14 of LG 1 operating from Tunis in 1943 in tropical camouflage 79/78 with blotches of 80. One third of the spinner is painted in red 22 or green 25. An interesting detail on the propeller blades is the technical data and the wearing away of the paint on the leading edge. Both the white fuselage theatre band and the nose-mounted 20mm cannon are visible.*

152: *This very clean Focke-Wulf Fw 58C is most probably finished in the European camouflage of RLM 71/65 with a meandering overspary in RLM 79, or possibly one of the Italian sand tone paints. All markings are entirely in accordance with the mid-war regulations. Despite being clearly in a desert setting, it has yet to acquire any theatre markings*

153: *Heinkel He 111H, WNr 4085, VG+ES, of the Kurierstaffel z.b.v Afrika in an unusual version of the 78/79/80 scheme. All visible Balkenkreuze and swastikas have a thin black border. Note the outlined letters on the white fuselage theatre band. Propeller spinners and blades were painted in 70 and it appears the spinners had a half or a third painted in white. The aircraft also had white wall tyres in accordance with requirements for tropical service. It is highly probable that* GFM *Erwin Rommel used this aircraft, which was lost on 9 August 1941 in a crash at Ain el Gazala*

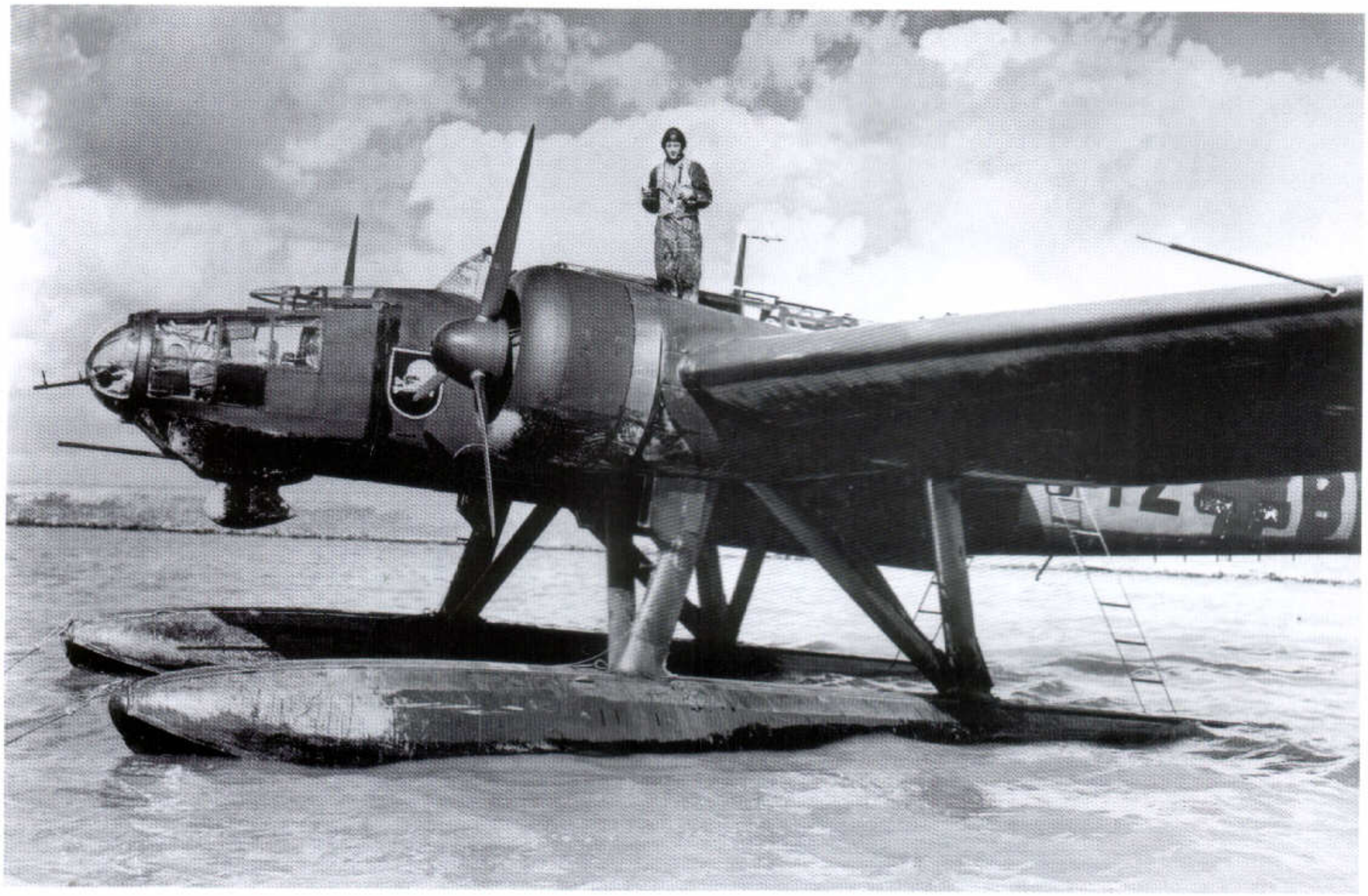
154: *A Messerschmitt Bf 110E-3 trop, 5F+PK, WNr 4427, of 2.(H)/14(Pz) about to be towed away by an SdKfz 7 half-track (which carries the staffel edelweiss emblem above its number plate). The aircraft appears to wear a weathered coat of overall RLM 79, possibly applied in the field over an earlier camouflage, as the upperwing Balkenkreuze are of the early narrow style. Undersides probably remained 65 or 76. Note the rather battered fuselage markings*

155: *Another Bf 110E-3 trop of 2.(H)/14(Pz), 5F+YK wears a different form of tropical camouflage. This time it appears to be RLM 78/79 with 80 blotches, on account of the high contrast with the white fuselage band. One half of the spinner is also white. It appears that the remainder is either Gelb 04 or 79; it is certainly not 70. All national markings are of the mid-war type with thin black outlines. The harshness of the operating conditions is revealed by the weathered and stained paintwork. Note the white wall on the tailwheel tyre which was intended to help dissipate static electricity*



156: *A Focke-Wulf Fw 58C of an unidentified unit in a camouflaged blast pen. The aircraft camouflage could be overall 02 with large blotches in 71, or possibly 79 with patches of 80. The engine cowlings, however, appear much lighter than the lightest tone on the fuselage. They could be light blue, light grey or even yellow. The propeller blades are certainly 70*

157: *Towards the end, the re was no time to apply tropical camouflage. This Bf 109G, 'Yellow 6', possibly at Anzio in Italy, still wears 74/75/76. The camouflage on the wings and tail is sprayed over masks with an unusual 'sawtooth' edge. This is clearly a misinterpretation of the rules directing merging of the edges between colours. The swastika lacks the black border, while the Balkenkreuz are the most simplified form, that on the fuselage being infilled with a dark tone, possibly 71, as it looks much darker than the 74 on the wings. Note the remains of a transit code ending in 'YY'*



MARITIME AIRCRAFT

Camouflage for two environments

From 1933 naval aircraft were painted overall in silver, as RLM 01 Silber. In 1935, however, a change took place when the following paints were introduced for the entire aircraft, as for shore-based machines:

DKH (Dr. Kurt Herberts) L 40/52 Grau *or*
Avionorm – Nitro paint 7375 Grau matt *or*
RLM 02 Grau

Floats and the underwater parts of flying boats, however, remained in RLM 01 Silber. The reason is obvious. The silver-coloured paints contained aluminium bronze as the colouring pigment, which provided additional protection against corrosion but made the paint very expensive. Consequently, the principle was light grey above water and silver below the waterline.

The draft L.Dv 521/1 of 1938 shows a top coat of RLM 04 Gelb for painting the upper surface of the wings, or the upper surface of the upper wing of biplanes, metal floats and flying boat hulls. This process is also confirmed by L.Dv 521/1, November 1941:

> "Shade 04 for naval aircraft camouflage has been abandoned."

In the camouflage instructions for the Arado Ar 196 the following shades are noted:

> "Camouflage
> The application of paint in Shade 04 as shown in drawings from E-Stelle Travemünde and RLM instructions of 24.05.1937, LC2 Nr.2890/39 (VI) geh.AZ 70k:
> The following is to be used:
> Airframe (Fuselage): Aircraft paint 7115.04 (Lacquer Group 22)
> Floats: Aircraft paint 7108.04 (Lacquer Group 02)"

Segmented camouflage was introduced in 1939 for all naval aircraft, as follows:

RLM 72	Grün	Green
RLM 73	Grün	Green
RLM 65	Hellblau	Light blue

This scheme was retained to the end of the war.

158 Above: *An Heinkel He 115C-1, M2+BL, of 3./Kü.Fl.Gr. 106 in 72/73/65. The aircraft has received a coat of the removable black night camouflage more or less in accordance with the instructions on page 224. Note that the black on the wing leading edge has been lost. Operational service and the harsh environment soon degraded the finish. Note how the temporary black has been used to tone down the Balkenkreuz as officially required, although the black should have been taken up the fuselage sides*

As naval operations also became ever more hazardous as the war progressed owing to Allied air superiority, most aircraft flew by night. This led to the underside of aircraft being painted for these night-time anti-ship operations in RLM 22 Schwarz (Black)

This was done both as a permanent coat and also as a removable coat in accordance with L.Dv 521/1.

159 Below: *The official camouflage pattern for the Dornier Do 24, taken from page 26 of the aircraft handbook*

162 Bottom right: *An overall light grey (probably DKH L40/52) Heinkel He 60 in service with the Kriegsmarine. The floats are silver from Flieglackette/Lacquer Group 03 (see page 205). The code numbers indicate that this is aircraft 'H' of 1 Staffel of 8 Gruppe within Luftkreis 6. The fuselage Balkenkreuze are of the early type with the narrow white sections which were later superseded by the type detailed on page 155. The upperwing is presumably finished in 04 Gelb*

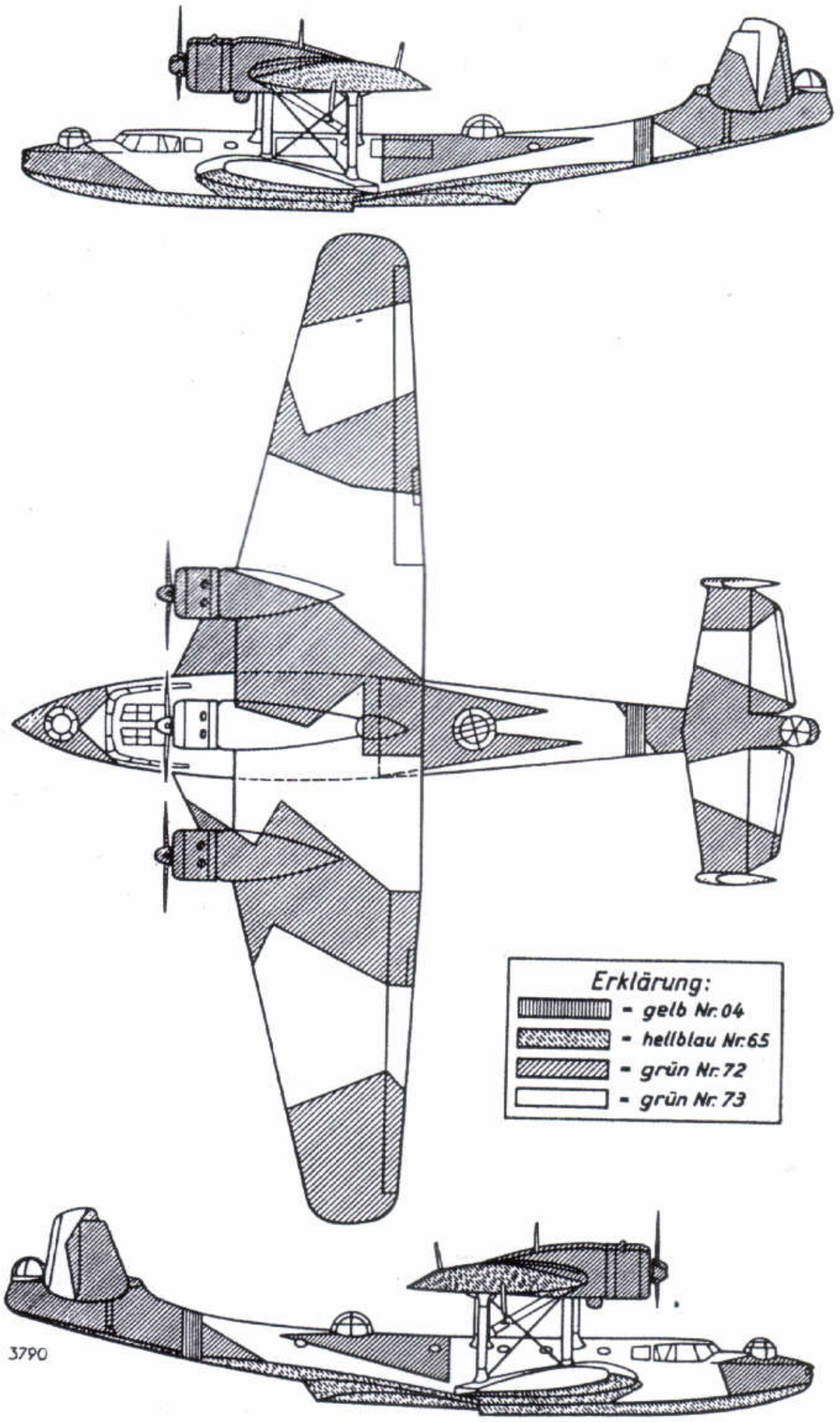
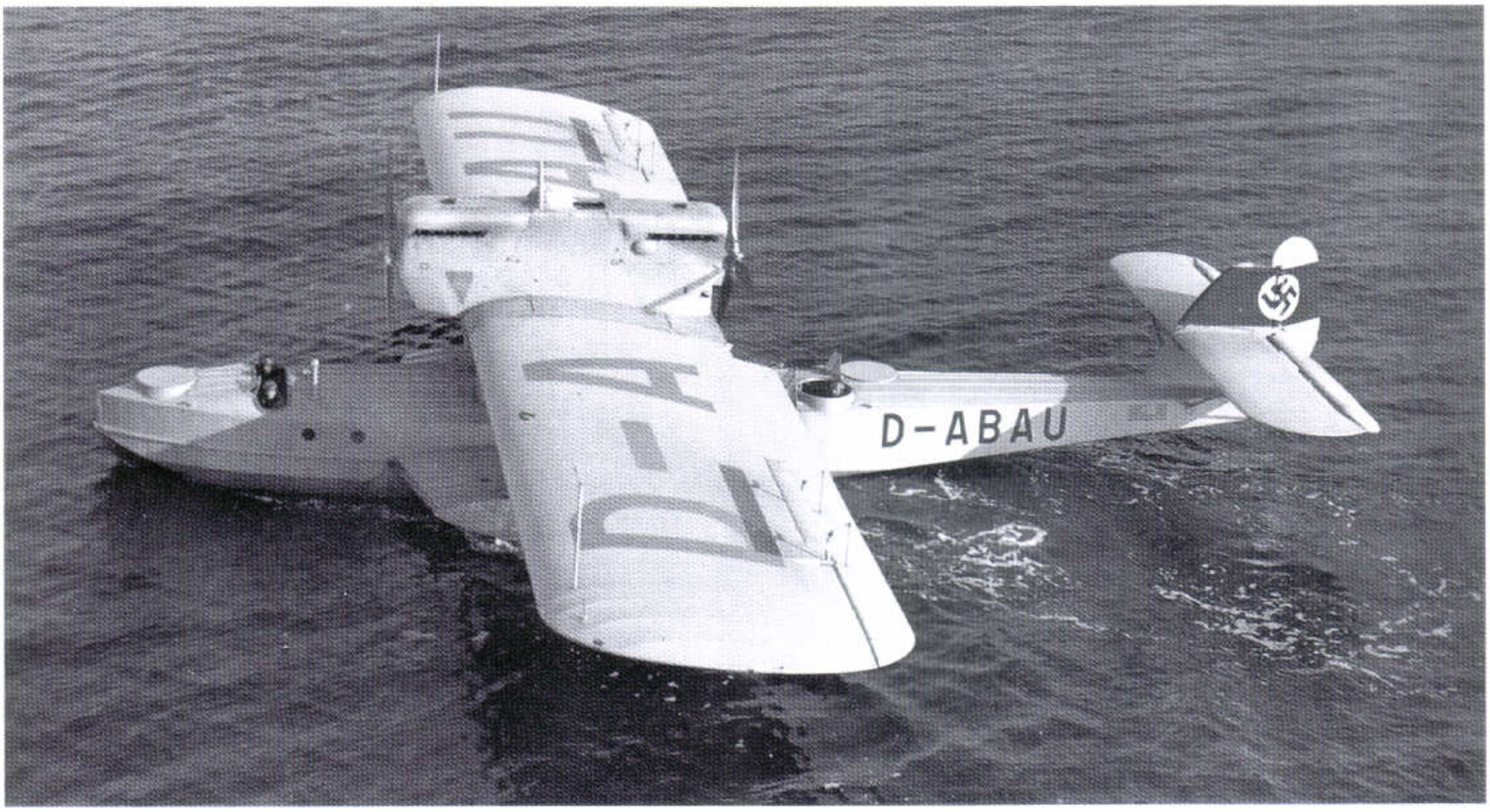
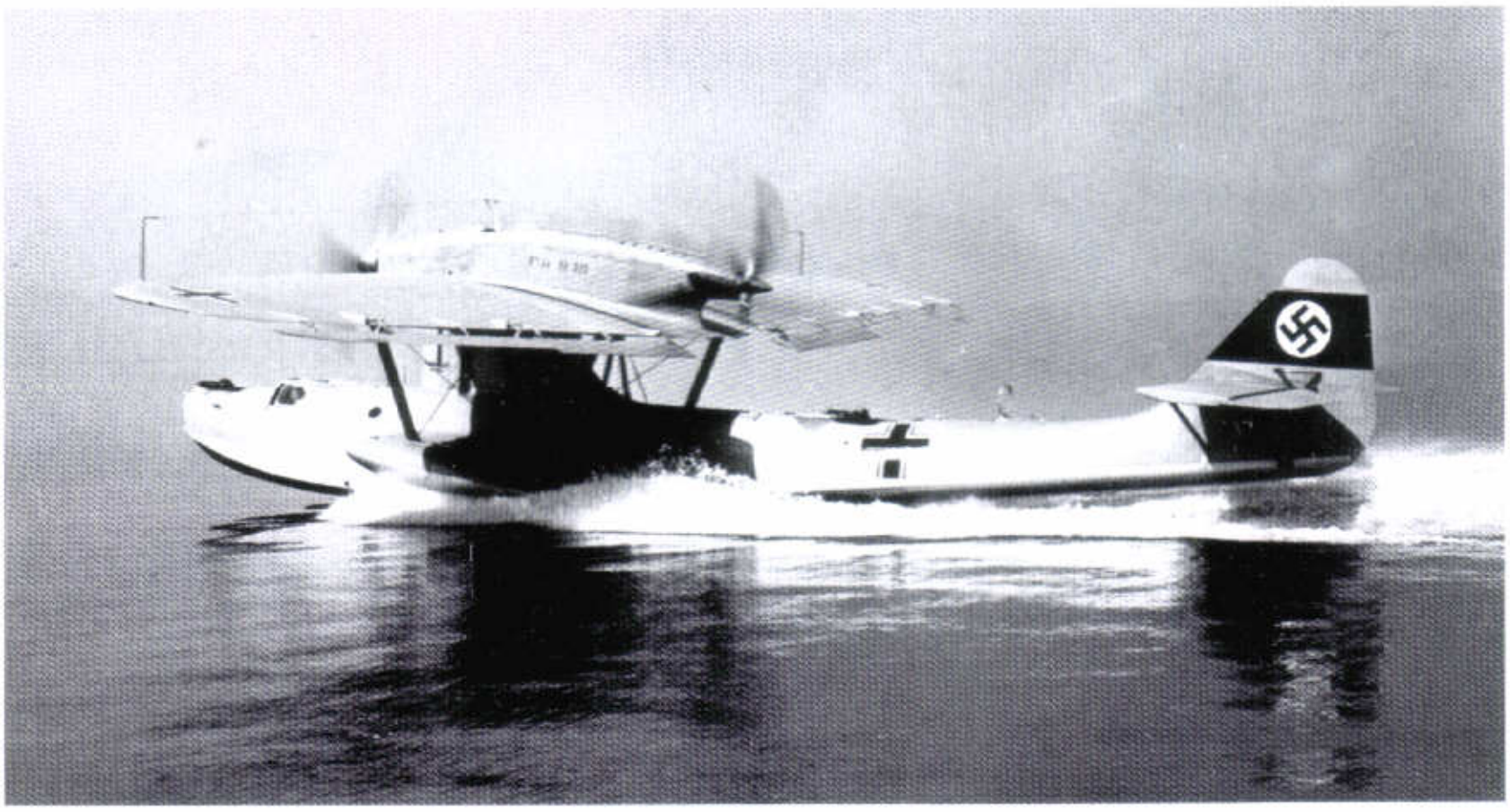


Abb. 11: Sichtschutzanstrich

160: *A line of Heinkel He 42B training floatplanes in Silber 01 drawn up on the slipway at Warnemünde. Civil registrations are in accordance with the regulations of the time which predate the Nazi era (see page 144). D-2033, the nearest machine was first registered in April 1931 to the DVS. This machine certainly survived until at least 1934. Note the small winged 'H' Heinkel trademark on the fin. The two aircraft just visible in the background are Heinkel He 9 monoplane floatplanes, world record holders in their day (AMC)*

161 Right: *Two Heinkel He 60s of a training unit in Luftkreis 6 and an He 59 multi-purpose seaplane. Both types display the light grey coat (possibly DKH L 40/52) with silver floats. The pre-war Luftwaffe tail markings with the swastika in a disc centred on a red band and the letter-figure combination on the sides of the fuselage can be seen*



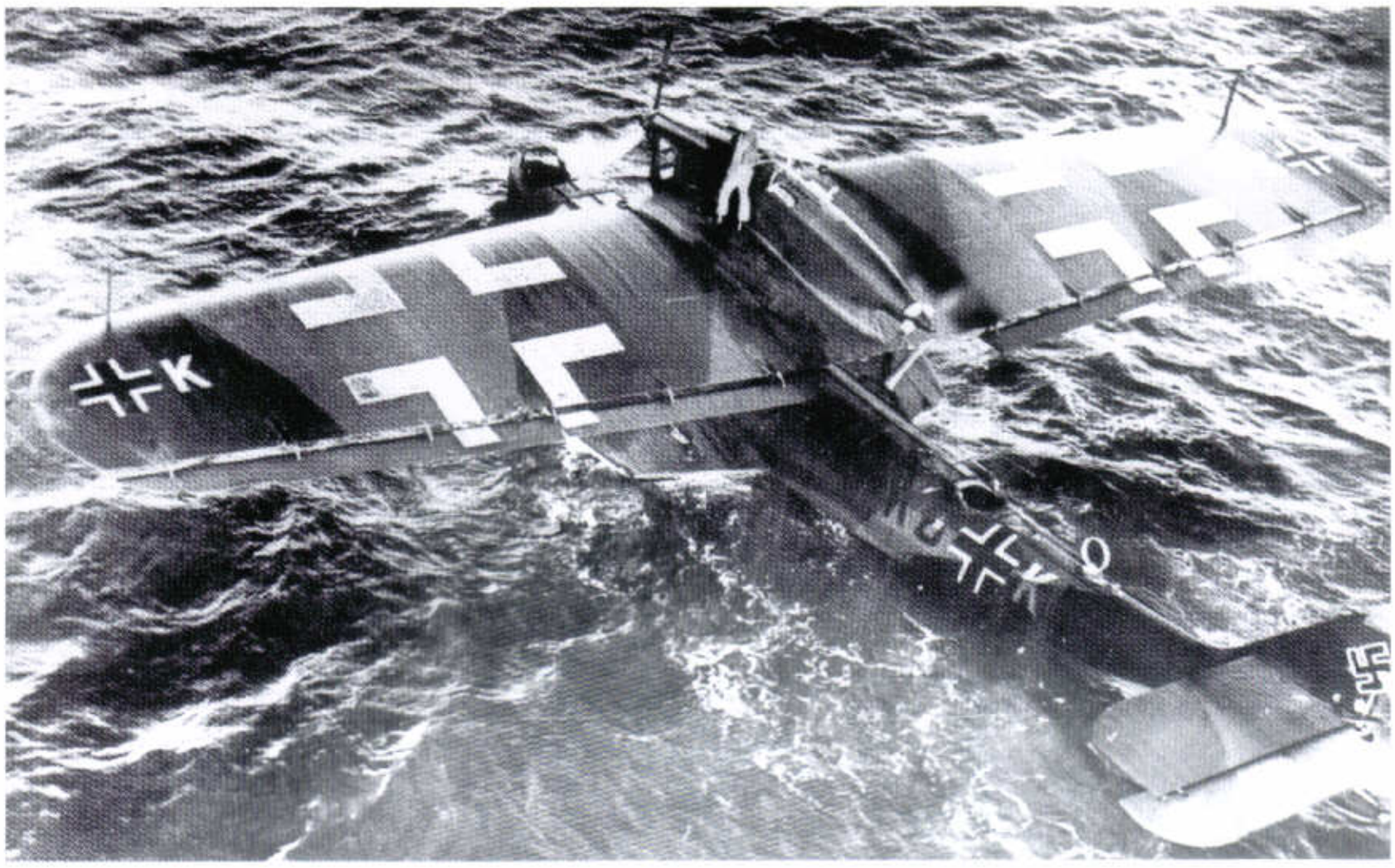


163 Above: *Dornier Do 16* Wal *D-ABAU, the militarised version of the Dornier Do J IId, with a cover civilian registration belonging to the Seeflieger staffel based at List, about 1935, probably in L40/52 Grau finish above the waterline. The wings may be 04 Gelb*

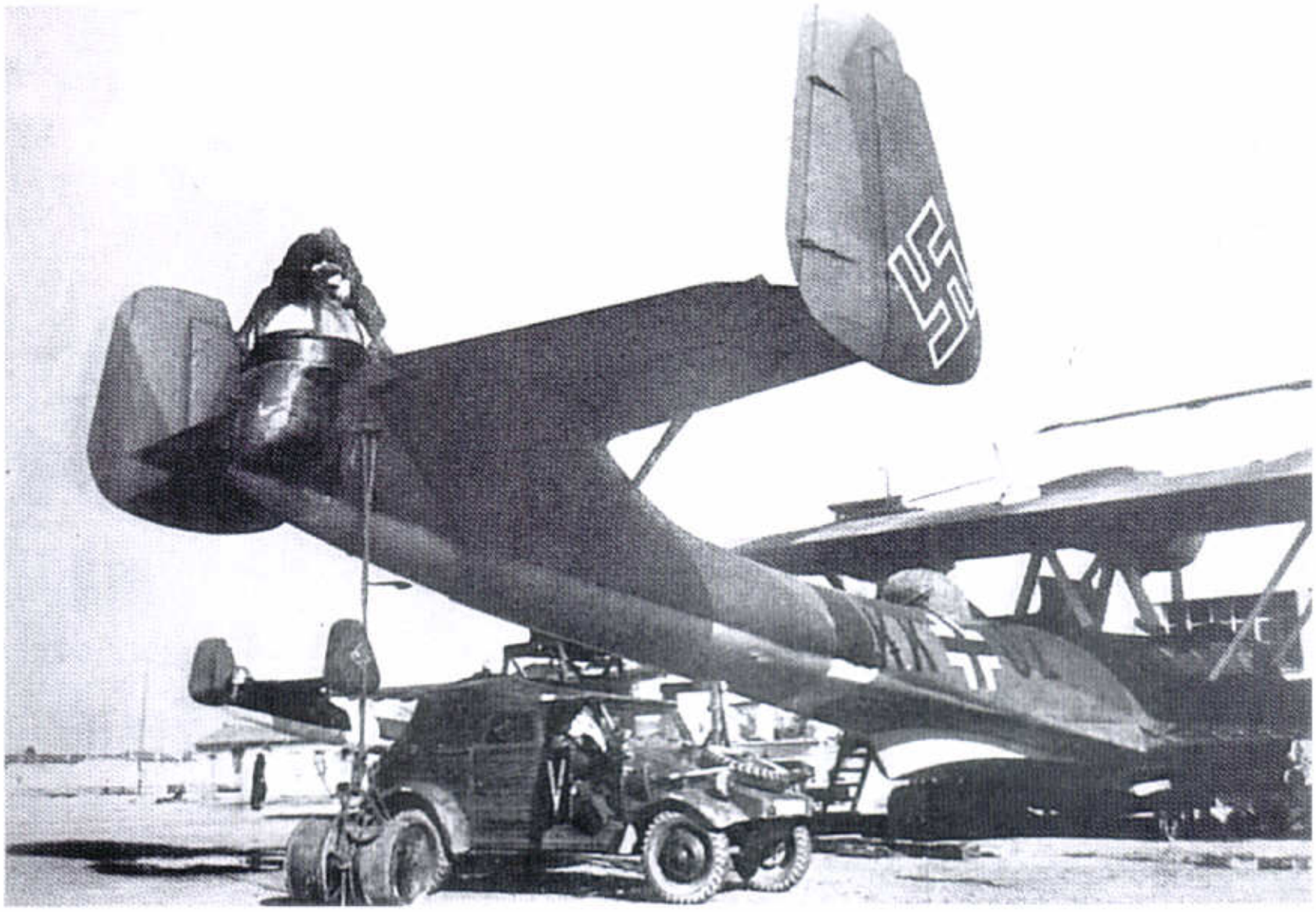
164 Left: *A Do 18D prior to delivery finished in overall RLM 02 above water and RLM 01 Silber below the waterline. The 04 Gelb upper-surface to the wing does not show clearly here but was in accordance with regulations* *(see page 85)*

165: *A photo of the very rare Heinkel He 51B-2 with floats. The aircraft was painted in the pre-war light grey L40/52, while the floats received a final coat of Silber 01 for maximum protection. All markings date from the 1936 period, the '60+A11' code indicating that the machine, 'A', is in service with 1./Küstenjagdgruppe 136, based at Kiel-Holtenau in late 1936. Note the manufacturer's trade mark on the propeller blade*

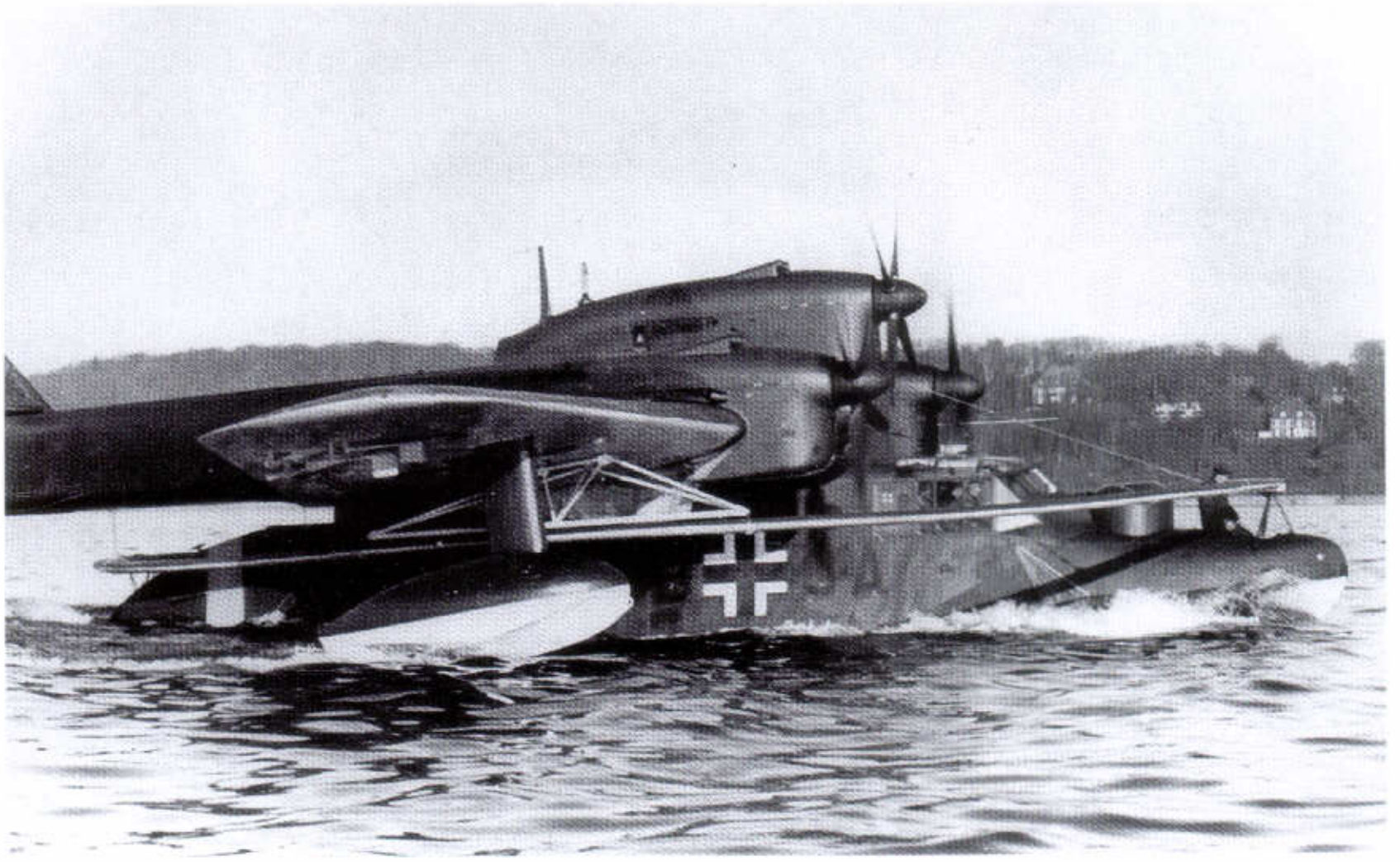
166: *The uppersurface of a Do 18D, K6+KH(?) of Kü.Fl.Gr. 306 camouflaged with 72/73 and 65. The outsized white-only Balkenkreuz are clearly evident in this picture. These seem to have been applied very early in the war, probably in response to a misinterpretation of orders. Other types to receive such gigantic markings were He 111s and Bf 109s*



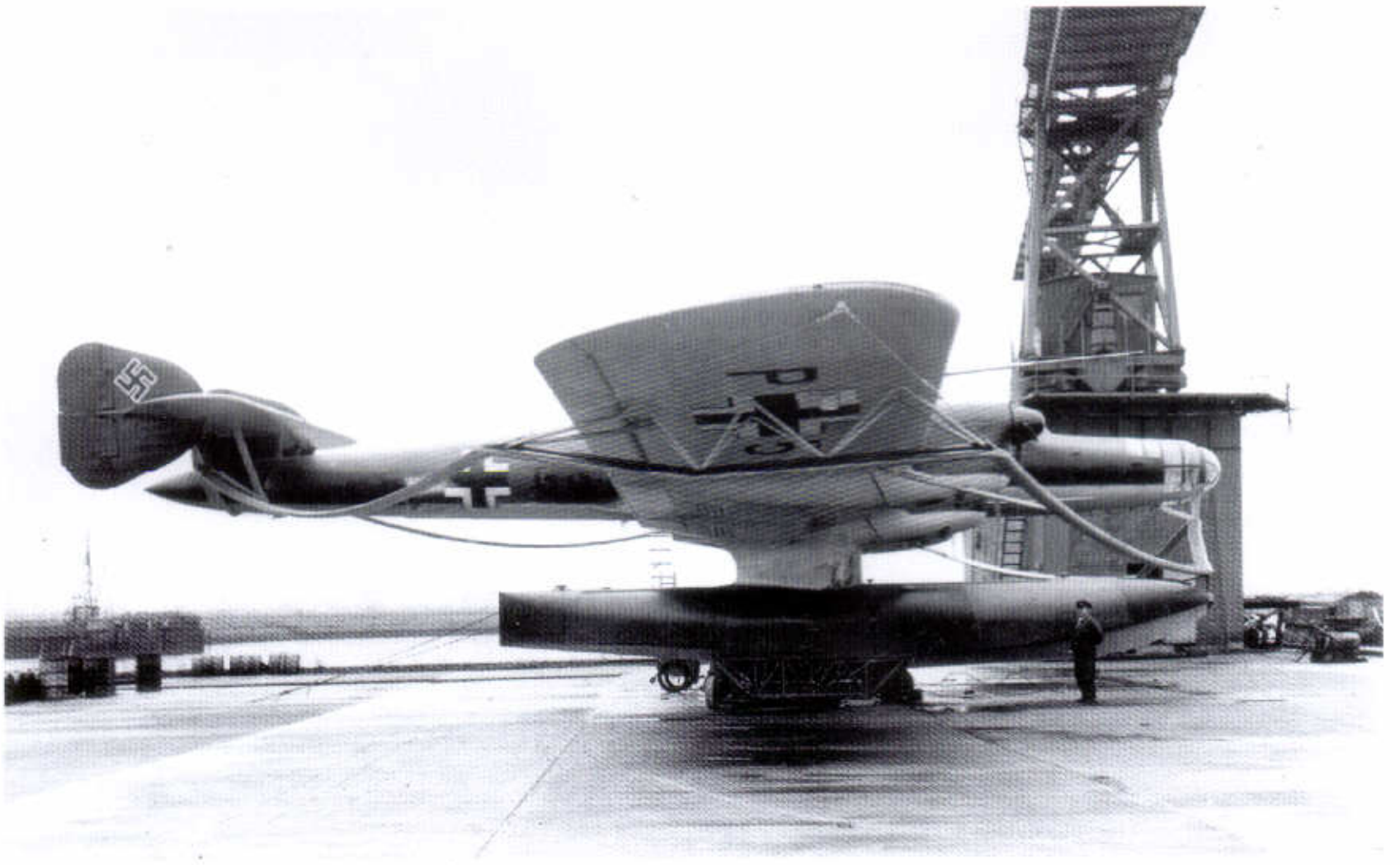
167: *The picture shows two D0 24T flying boats (possibly of Seenotstaffel 7) with noticeable differences in the application of the paint. It is clear that the white fuselage band of the nearer aircraft, which still wears its delivery code, KK+UZ, was overpainted on the upper surface. The machine at the rear still carries its fuselage band, but this was painted larger than on the boat in front. There are also differences in the way the camouflage was applied to the two aircraft. Note the ubiquituous Kübelwagen*



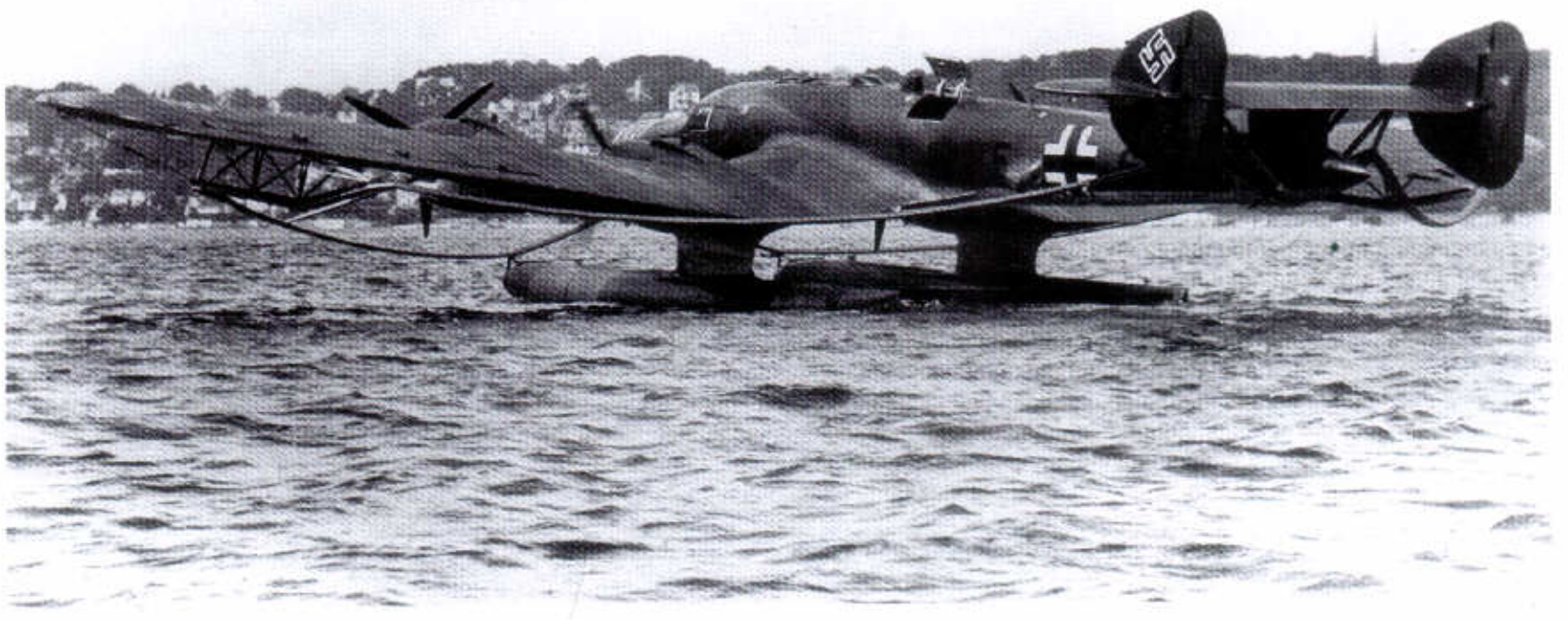
168: *A Do 24, J9+GA, of Seenotstaffel 7 in 72/73/65 camouflage. Balken- and Hakenkreuz are in the 'late' style with just the white angles. The fuselage band has been overpainted. Note the brighter patch to the left of the Balkenkreuz which indicates that an old call sign has been overpainted. All three spinners wear a spiral in white, indicating a date post-July 1944*



169: *A Blohm & Voss BV 138MS, CB+UA, WNr 310021, undergoing testing at Travemünde in summer 1941. It is finished in 72/73/65 camouflage and it is clear that the entire propellers, including spinners, were RLM 70. The aircraft carried a white or yellow fuselage band and the simplified type of the Balkenkreuz without the thin black border. This was originally the first C-1 variant, as shown by the four-bladed propeller to the middle engine*

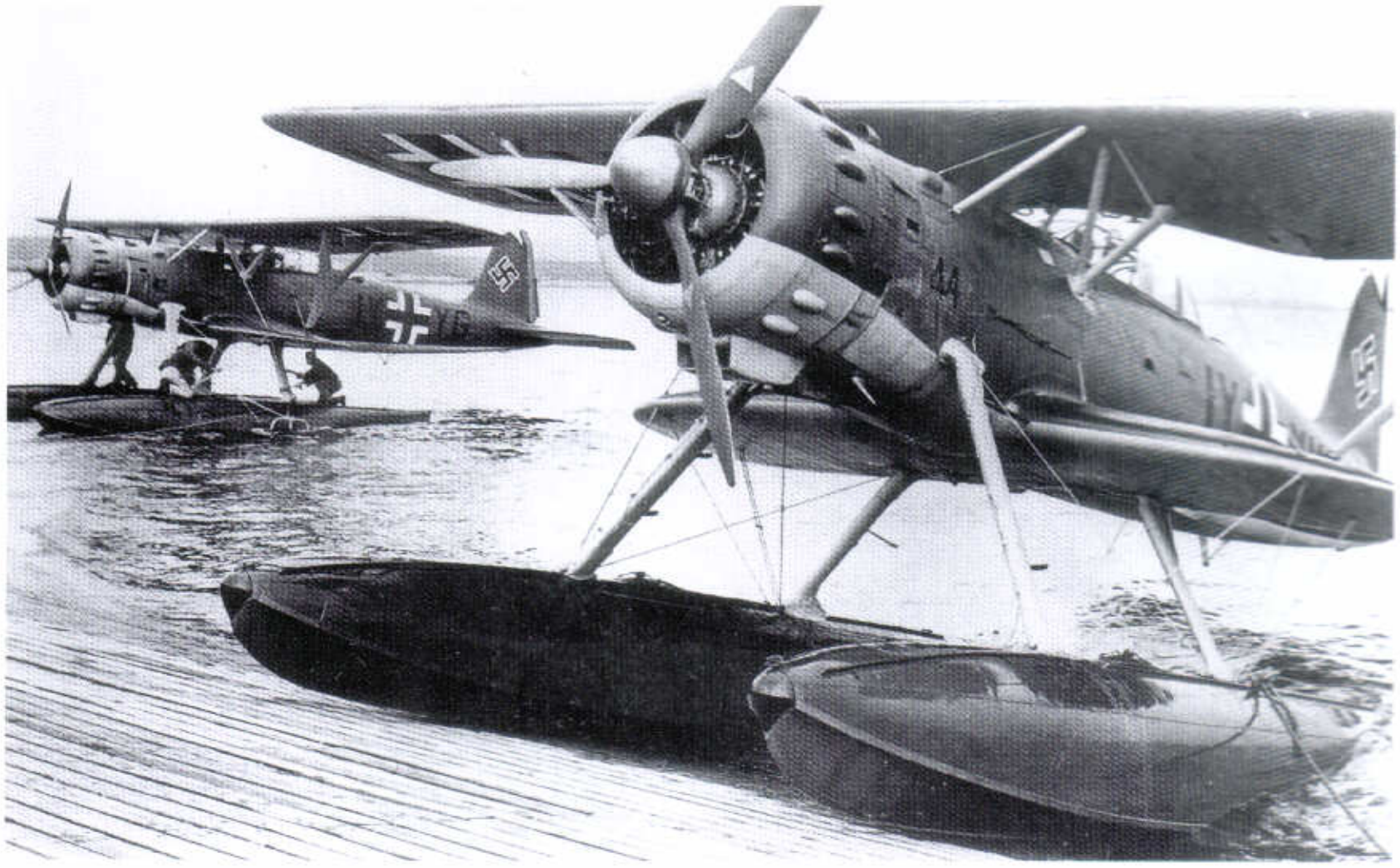


170: *The Blohm & Voss Ha 139V3/U1 seen in 72/73/65 camouflage. Originally this was built for Lufthansa as D-ASTA* Nordstern, *which can be seen in its civilian guise on page 21. As shown here it is in Ha 139 V3/U1 form, coded P5+GH, indicating service with Sd. Staffel Kü. Fl. Gr. 406. All visible national markings are from the early war style with thin black border. The aircraft is very clean, seen shortly after it was converted to the minesweeping role*



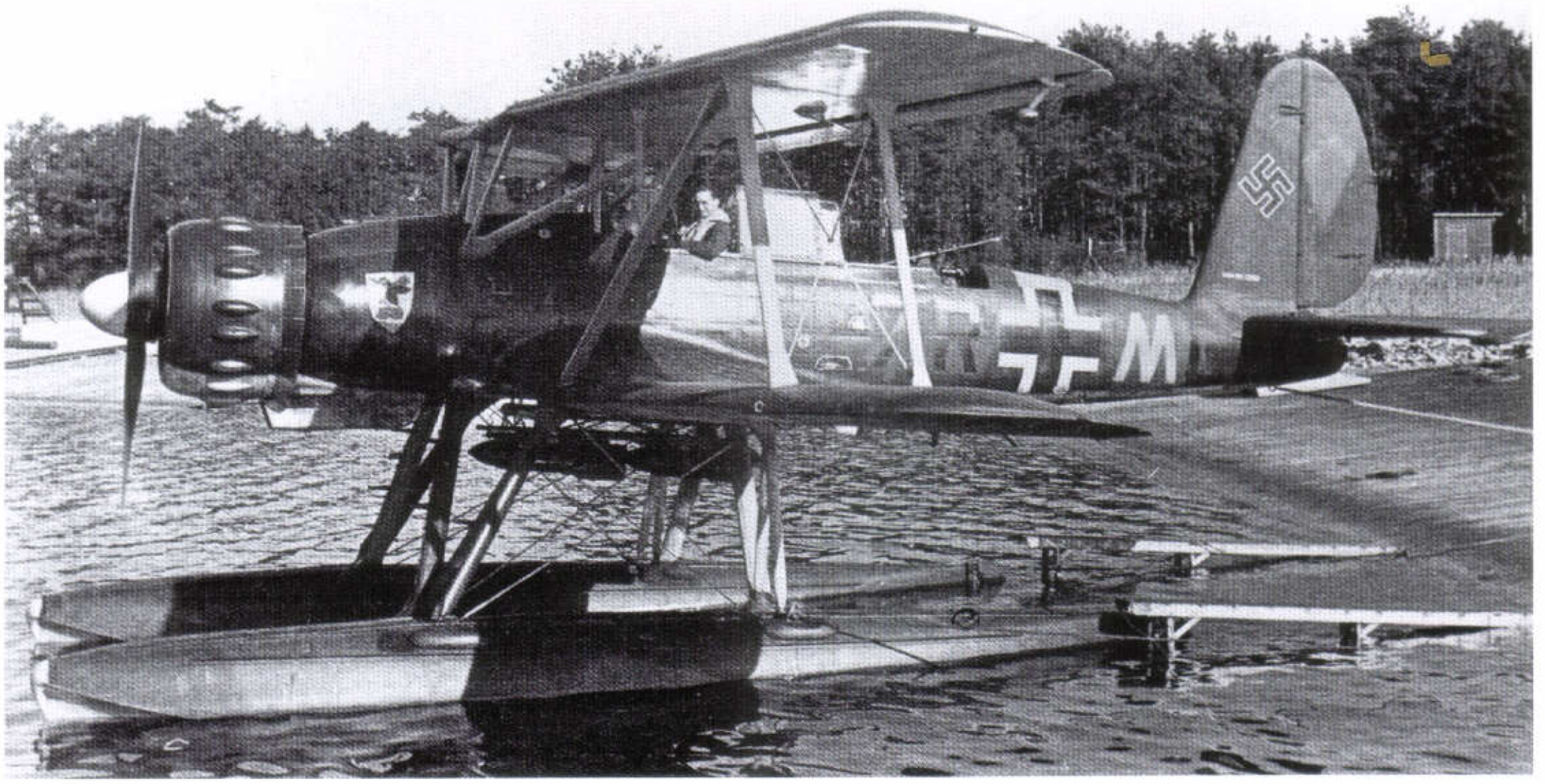
171: *Another view of the Blohm & Voss Ha 139V3/U1, P5+GH, WNr 217. The differences between the aircraft in this form and as D-ASTA are clear. The splinter camouflage pattern in 72/73 is clearly evident*

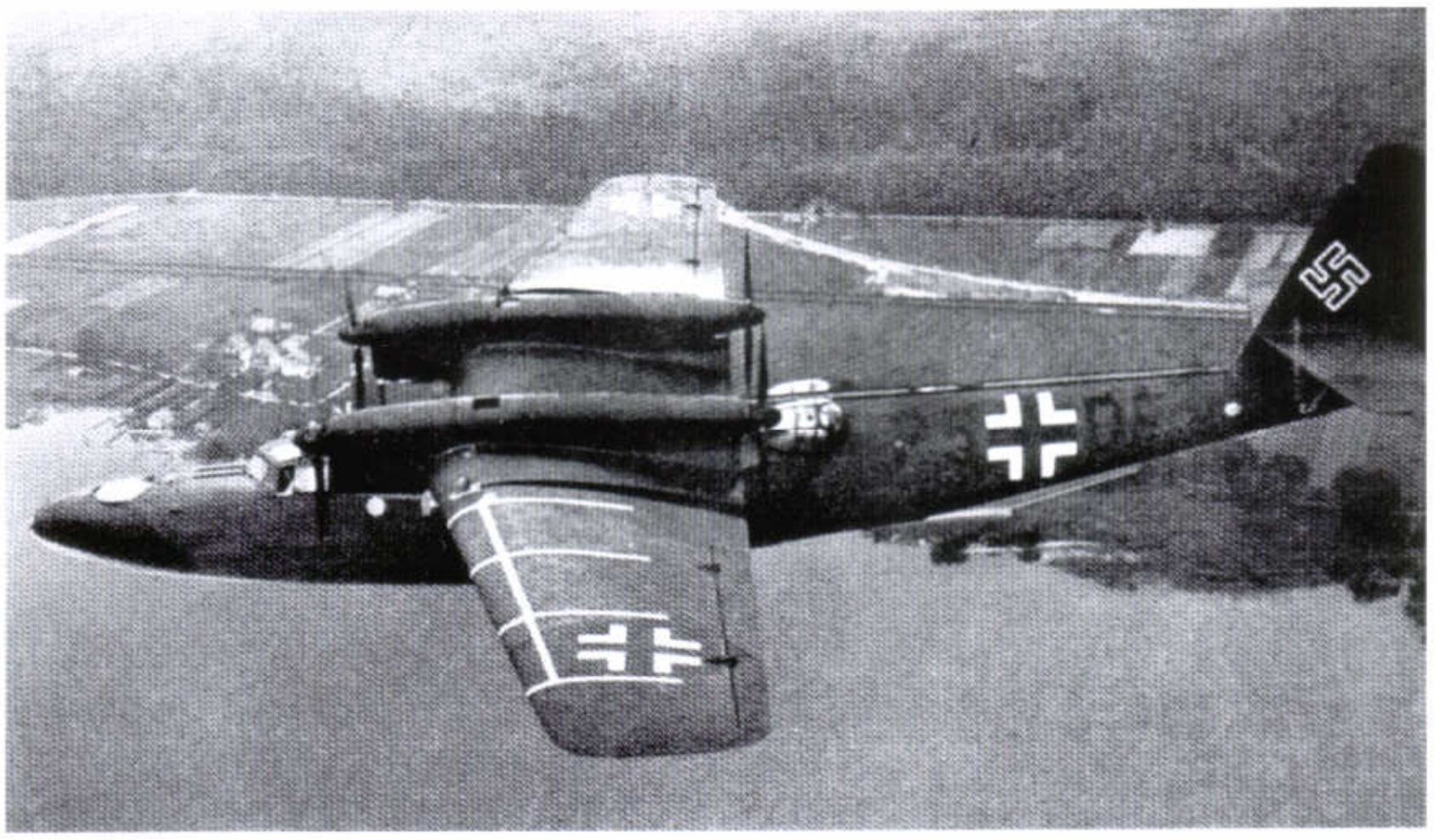
172: *Two Heinkel He 114As, probably undergoing manufacturer's pre-delivery trials on account of the fuselage codes, IY+YK and IY+YG. Both have a typical 72/73/65 camouflage. All visible Balken- and Hakenkreuz are in the early style with thin black borders. The tip of the spinner on the nearest machine is painted in Gelb 04*



173: *Heinkel He 114, WNr 2562, 7R+EH of S.A.Gr.125 in 72/73/65. Note the early style Balkenkreuz and swastika with thin black border and the unusual position of the yellow fuselage band. The style of the letters looks handpainted, the white aircraft letter 'E' (repeated under the wing) appearing to be bigger than the 'H'. Oil leaking back from the BMW 132K engine is probably responsible for the shiny finish to the paint on the forward fuselage, while the subtle difference between the greens of the paintwork can be seen on the float*

174: *A Ju 52/3m over the Aegean Sea. The floats look very worn, the paint on the under water portion has been stripped away. The aircraft had a white fuselage band indicating service in the Mediterranean theatre but the unit is unidentified. All visible national insignia appear to be of the late simplified style*



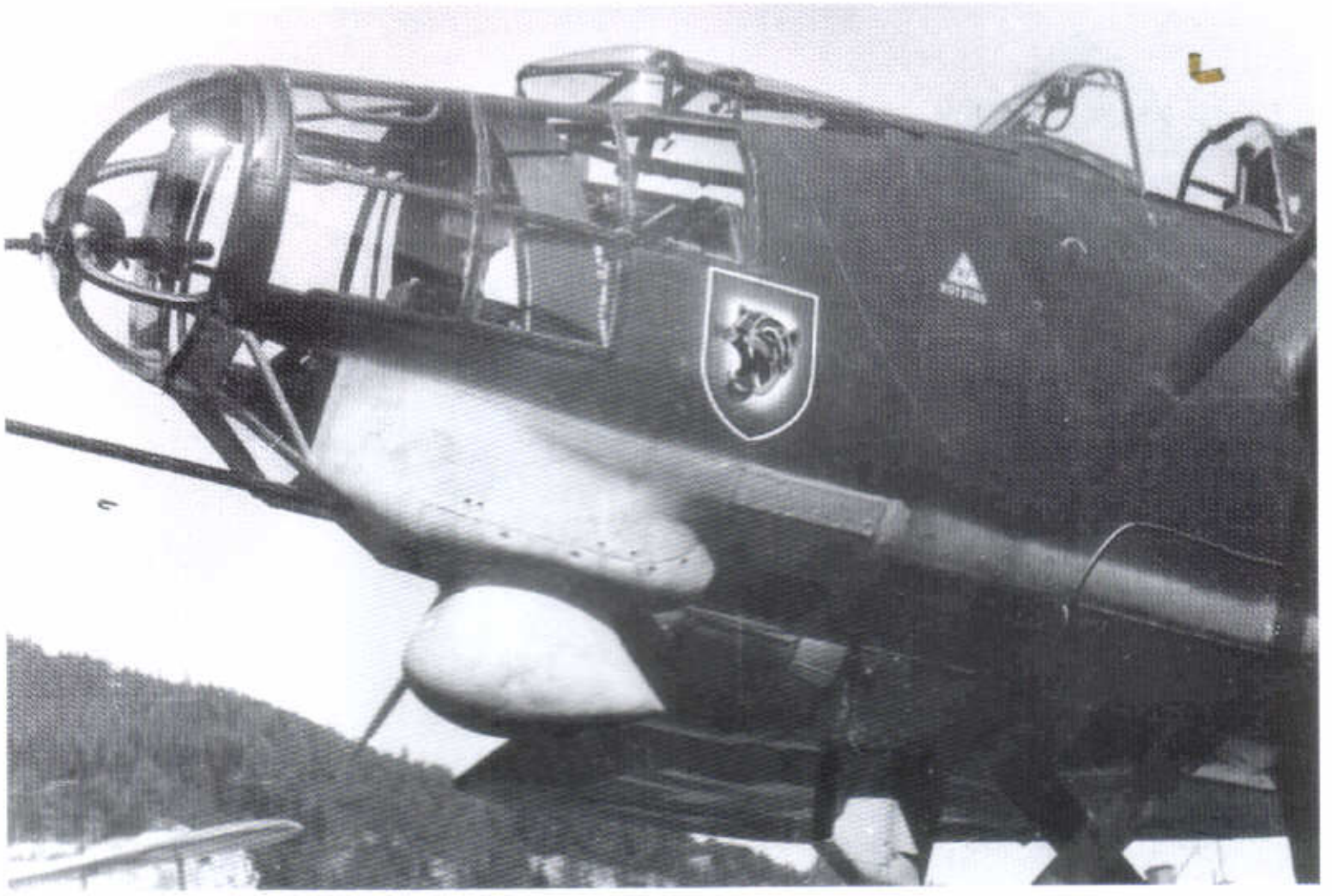


175 Above: *Arado Ar 95A-1 WNr 952350, 7R+ML of 3./SAGr. 125 in the Baltic in 1941, wearing 72/73/65 camouflage. Only a small portion of the yellow theatre band has been applied to the fuselage spine. The complete aircraft had a very glossy finish, possibly the result of an extra coat of gloss clear lacquer (Flieglackkette 20) to give better surface protection in the harsh environment. The tip of the propeller spinner is in white.*

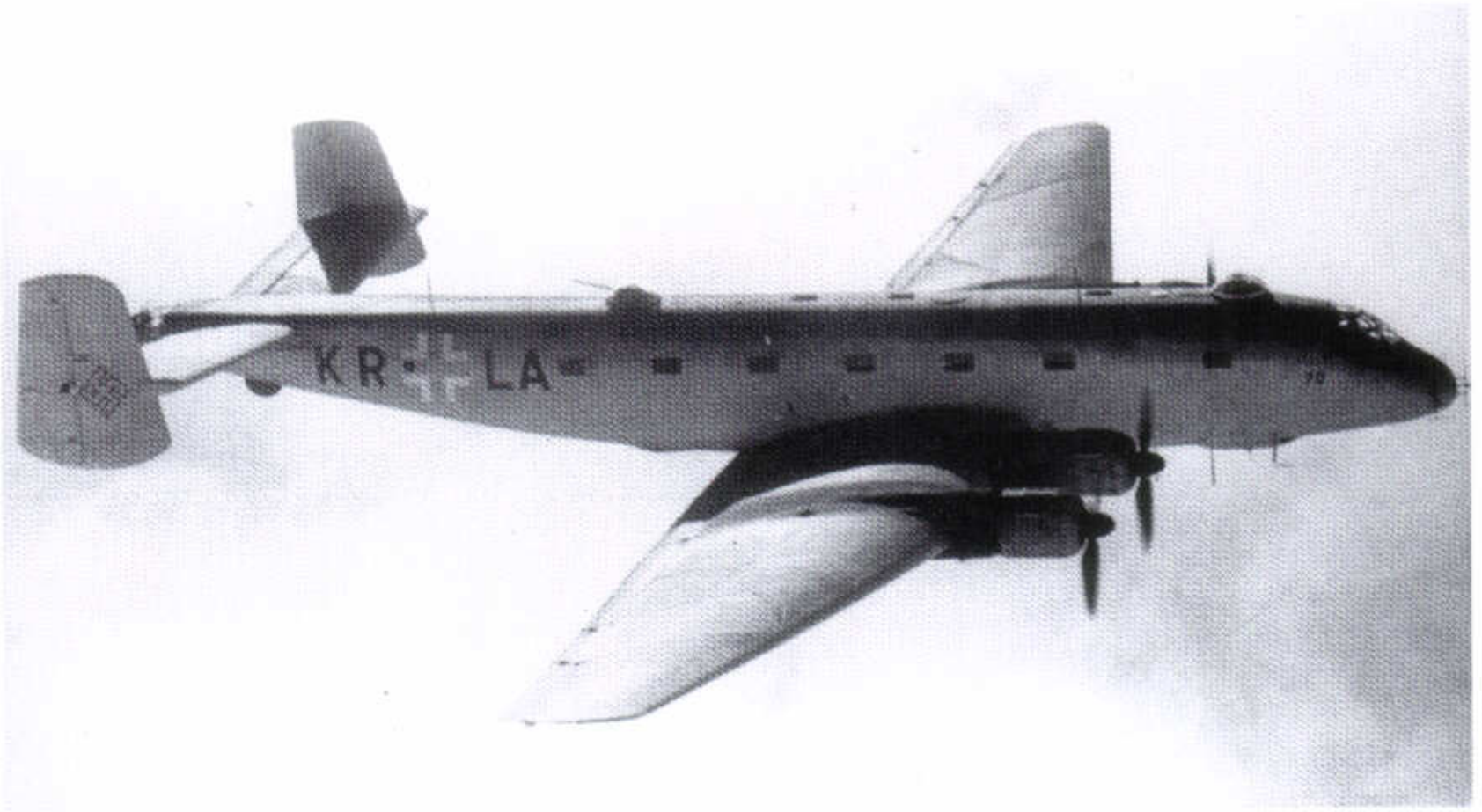
176 Left: *The Dornier Do 26V4 after modification to suit it for service with the Tranzozean Staffel of Kü.Fl.Gr 406. Finished in RLM 72/73 it carries the unit code P5+DF. The purpose of the white wing markings is unknown*

177: *The fuselage of an Heinkel He 115, T6+KH, WNr 2503(?), of 1./Kü.Fl. Gr 406 based in Norway, showing the early style swastika and Balkenkreuz with the thin black border. All letters were painted in black, the letter 'K' with a white border has apparently been recently painted over an earlier letter. The well worn camouflage is 72/73/65*

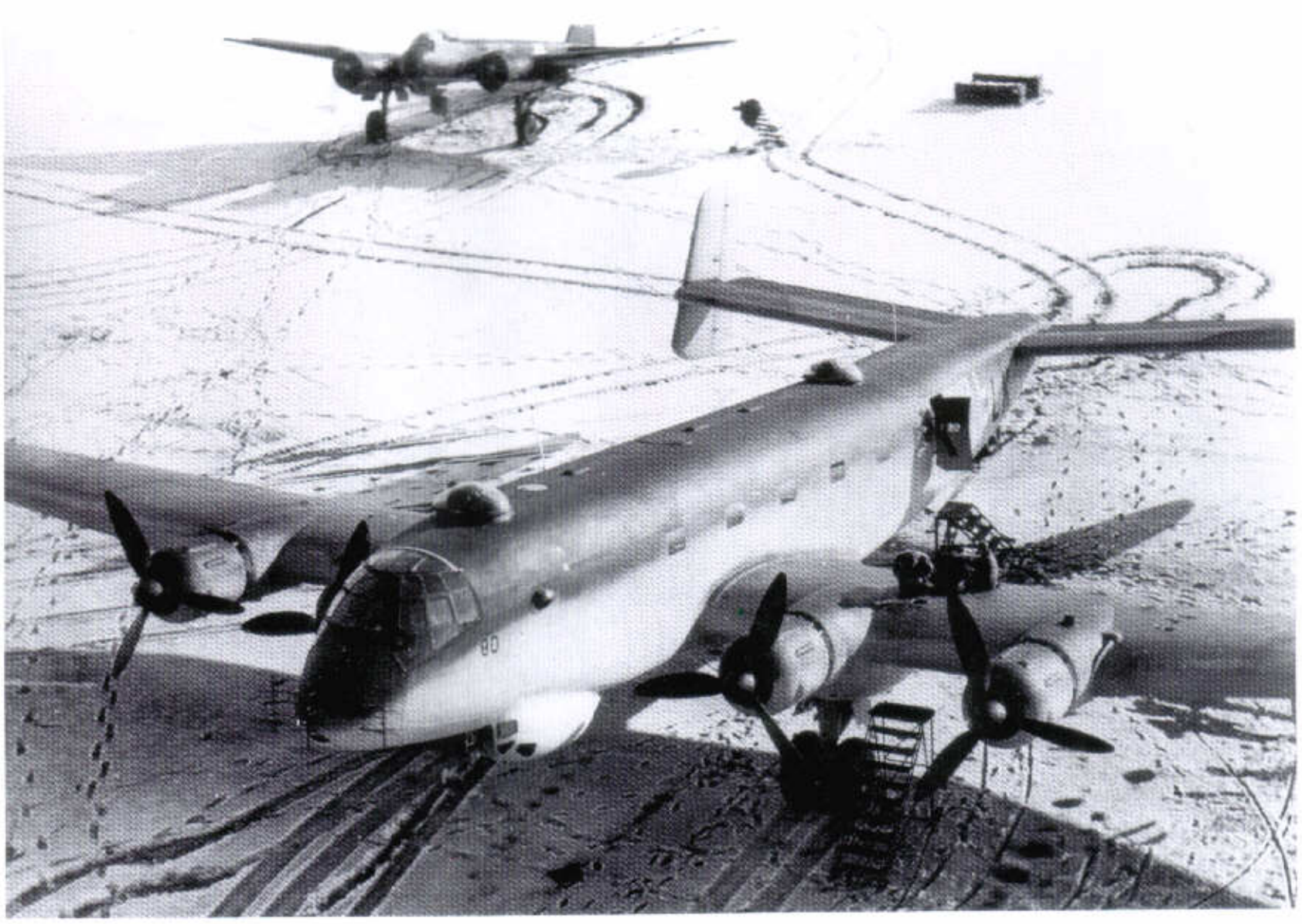
178: *The nose of this He 115C-1 of 2./Kü.Fl.Gr 506 gives a good impression of the effect of weathering on the two maritime colours, 72 and 73, which are now barely distinguishable from one another. The underside 65 appears very light by way of contrast. Note the 87 octane triangle*

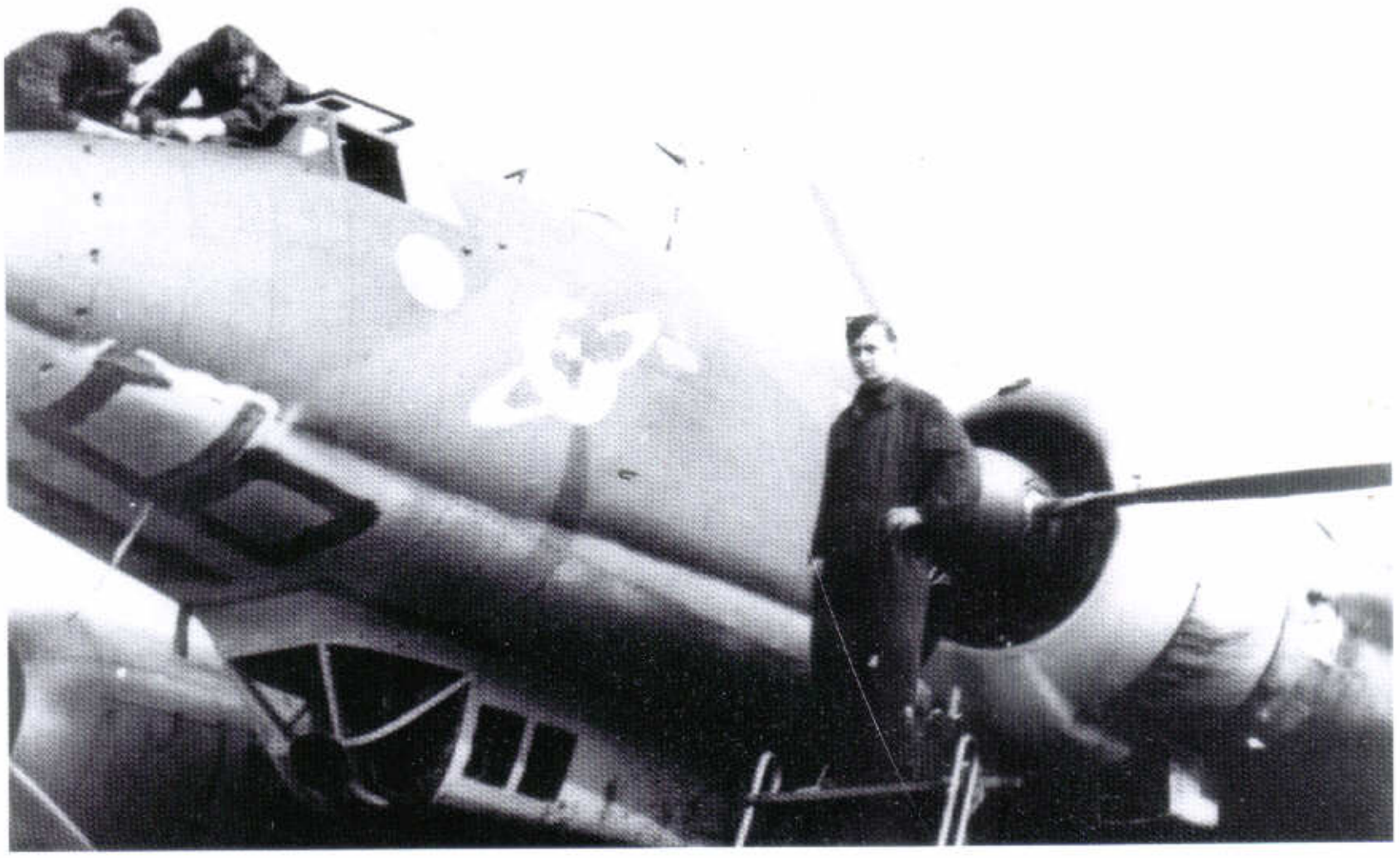


179: *Junkers Ju 290A-5, WNr 0170, in 72/73/65. In this case the colour demarcation line is much higher than usual. The black swastika is in accordance with the requirements for maximum simplification, but the white fuselage cross is not because it is on the bright colour 65. It should be in black. Maybe the unit decided that the light cross gave better camouflage. Shown here in early 1944 under trials at Rechlin, it was later delivered to 1./FAGr. 5 as 9V+DH*

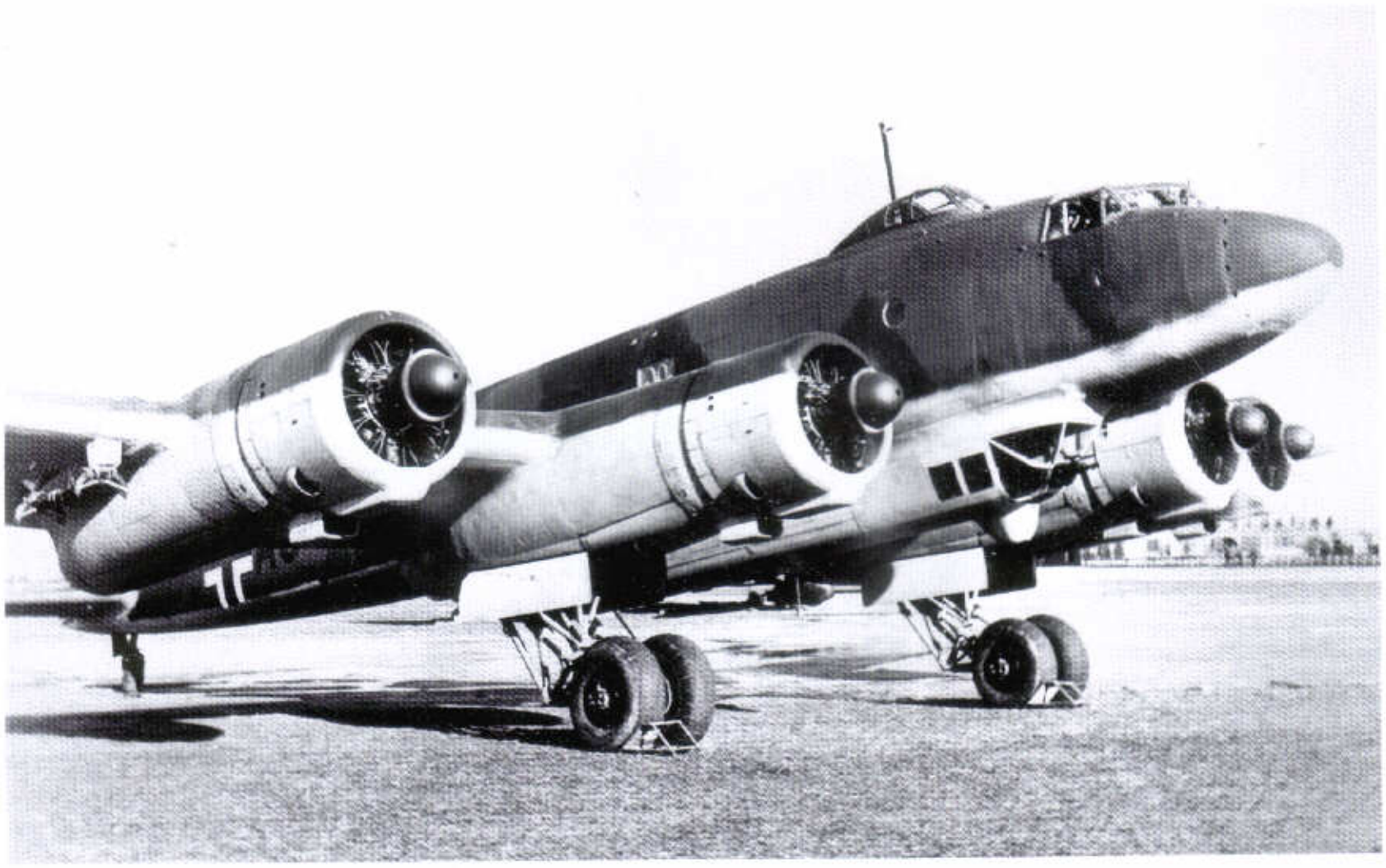


180: *Seen at the Junkers works at Dessau on 23 March 1944, this is Ju 290A-5, WNr 0180, KR+LK, fitted with FuG 200 'Hohentwiel' radar and painted in 72/73/65. The colour demarcation on the fuselage is, as usual for this aircraft type, very high. The transition between the upper and lower surface colours is very soft compared to the relatively sharp demarcation line on Fw 200s. The partly visible fuselage Balkenkreuz is white, infilled with the dark topside camouflage colour as required by regulations. (See page 252). Sent to 1./FAGr. 5 and coded 9V+KH, the aircraft was destroyed on the ground at Rechlin on 10 April 1945*





181: *Seen at Cognac, France, in May 1942, this Focke-Wulf Fw 200 of KG 40 wears the specified 72/73/65 camouflage. Repairs are being carried out underneath the cockpit as prescribed by the OS-List for the type. The dark stripes are paint 7102 from Fliegerlackette Group 01 (see page 213). After this the final coat of lacquer 7122.65 will be applied (see page 224)*

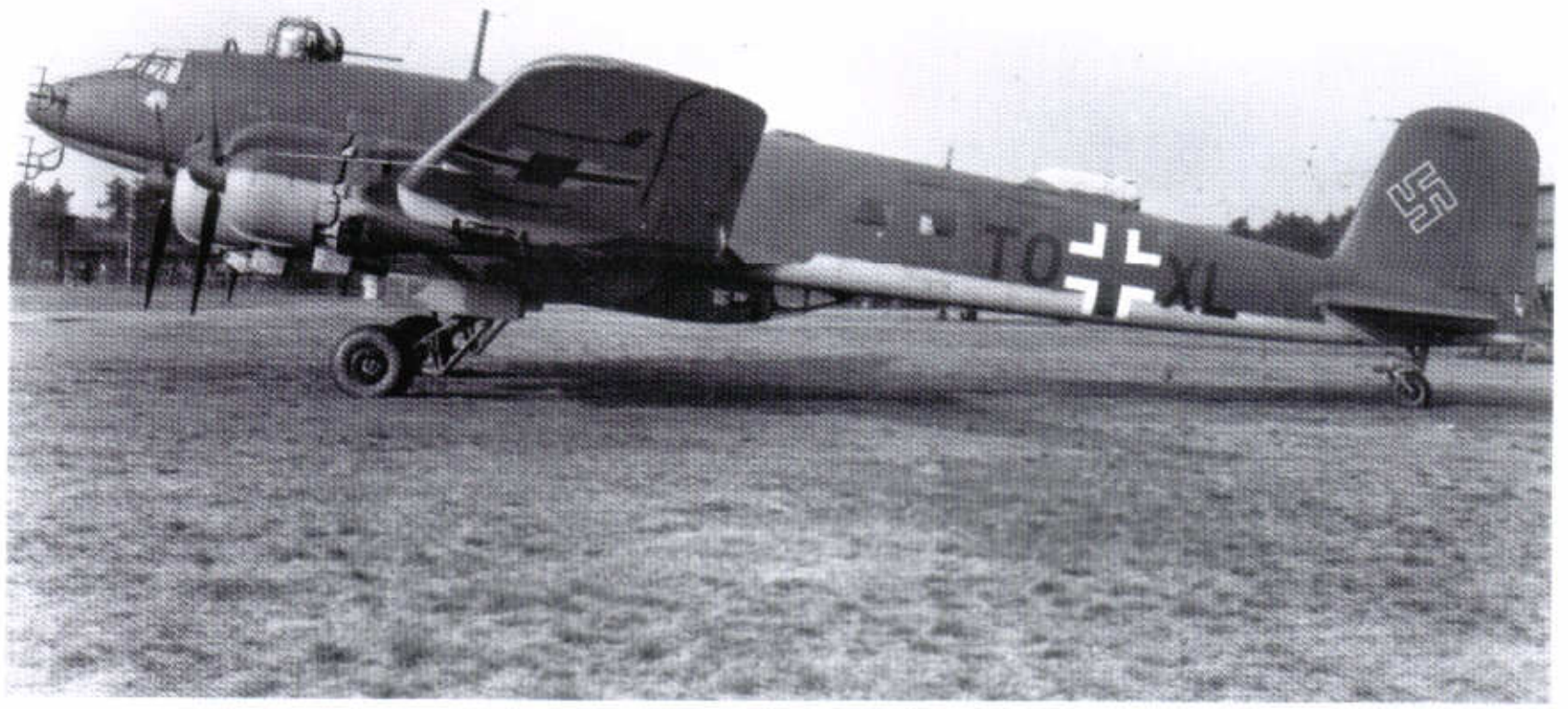


182: *Wearing the delivery code BS+AJ, this is Fw 200C-1, WNr 005, undergoing weapons testing at Tarnewitz in early 1940. It is finished in 72/73/65, with the under surface colour very high up the sides of the engine nacelles and wing leading edges. This was obviously found to be unsatisfactory as later aircraft had the entire leading edges finished in green and the line accordingly brought lower on the nacelles and cowlings. The aircraft was never operational as it crashed and was written off on 23 March 1940*

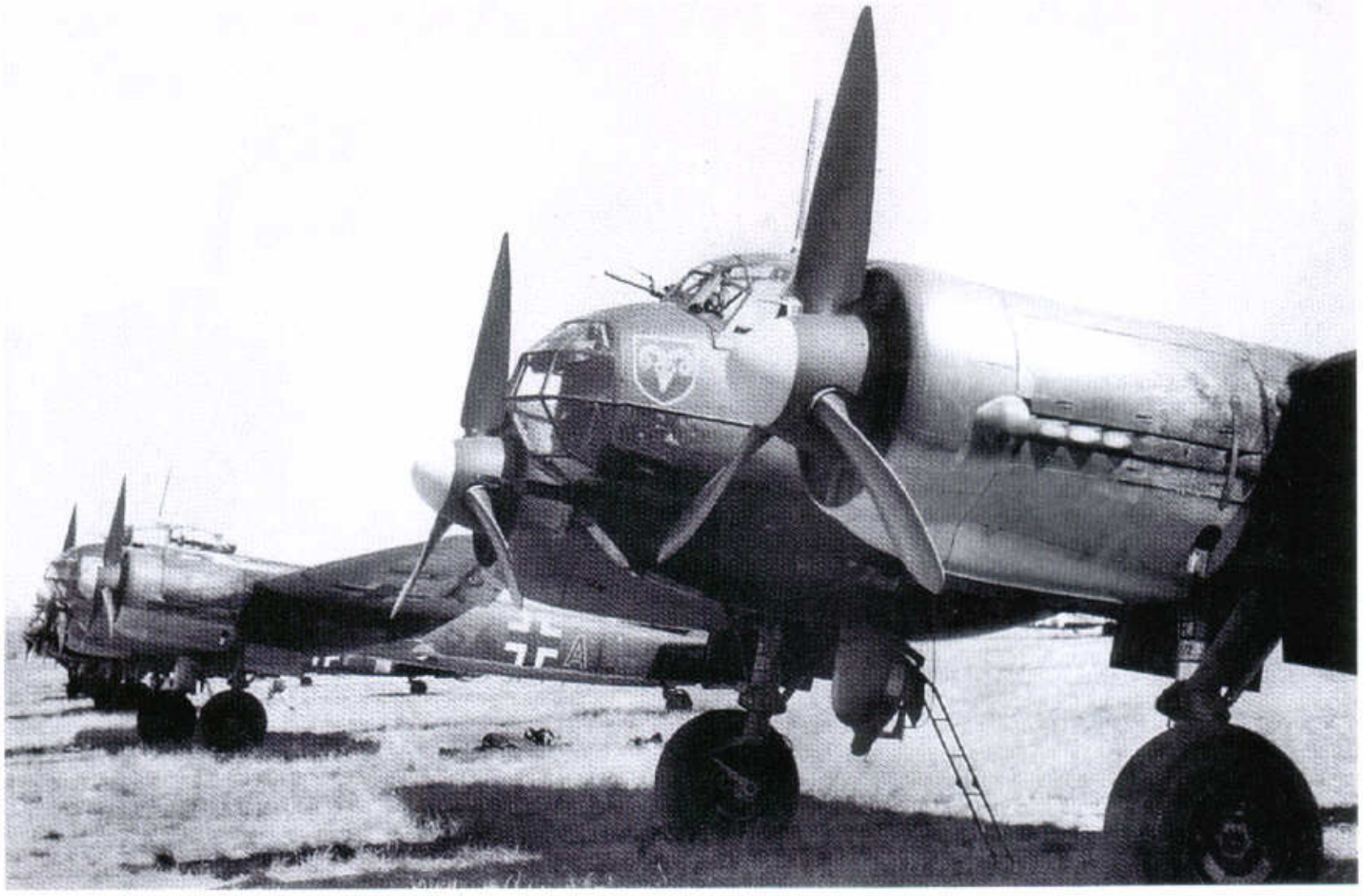
183: *This port side view of the same Fw 200C-1 seen in photo 182 gives a very clear idea of the uppersurface camouflage pattern. The angle of the strong sun makes the contrast between the two upper surface colours seem much greater than usual and the wing underside appear to have a darker portion behind the cross. Markings are entirely standard for this early date in the war, including the full code under the wings*

184: *Fw 200C-8, WNr 0256, TO+XL, fitted with Hohentwiel radar and finished in 72/73/65. The uneven demarcation line between upper and lower colours resulting from hand spraying is obvious. Landing gear and insides of the wheel wells are painted in RLM 02, wheel hubs in RLM 22. Clearly visible is the 30mm wide unpainted strip at the root of each propeller blade, intended to allow blade alignment (see page 247). Propeller spinners and blades are painted in 70 as required*

185: *This port side profile view of Fw 200 WNr 0256 reveals the underwing bomb racks and dorsal turret. Only twenty of the Fw 200C-8 models were produced. Note that the simplified fuselage Balkenkreuz has been infilled with 72 or 73 and the swastika is a white outline only, as required by regulations. The overall dull finish is worthy of note*

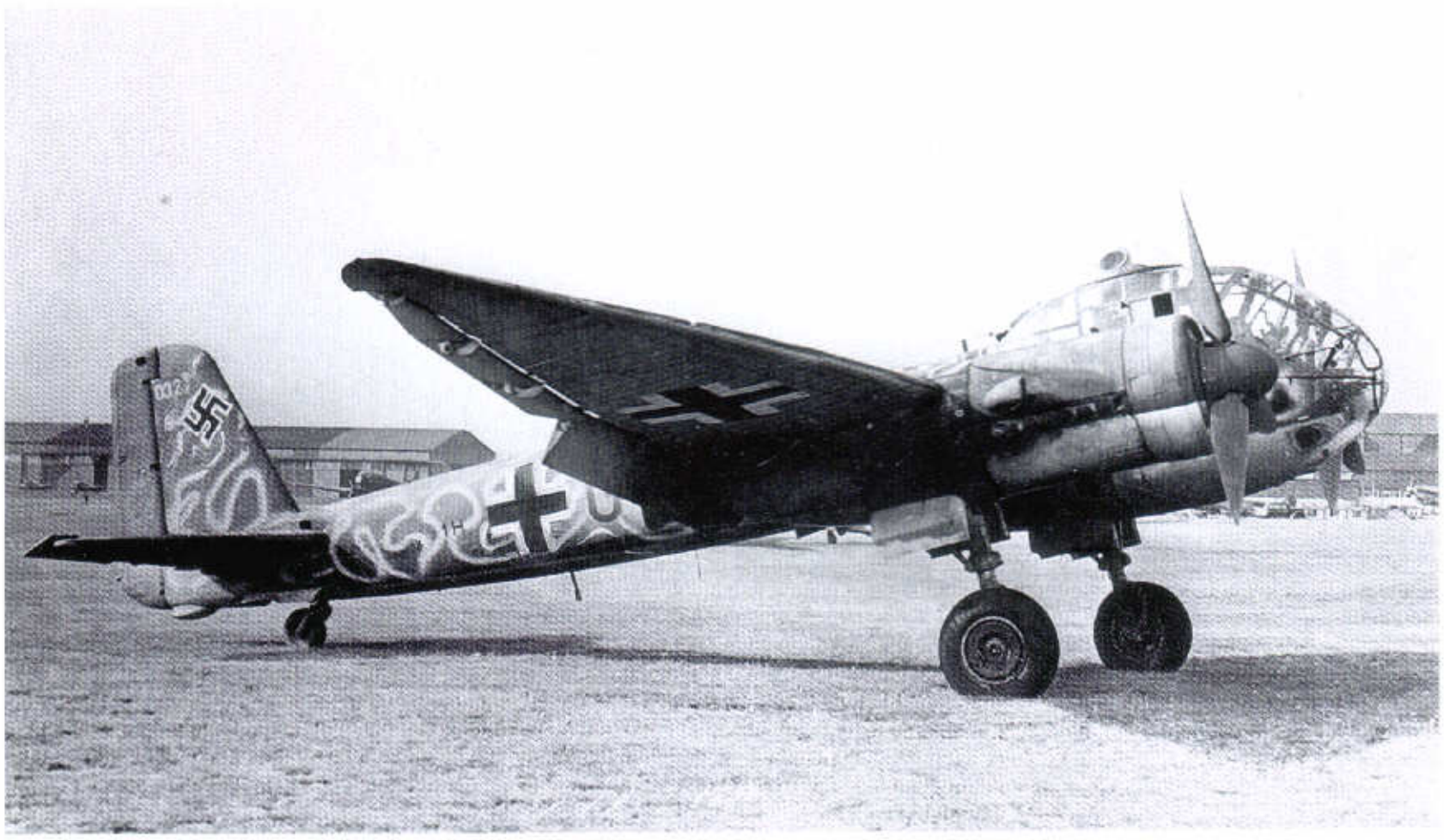


186: *This Fw 200C-3 or C-4, F8+FR of 7./KG 40, was found abandoned in Norway at the end of the war. The standard 72/73 upper surface camouflage on the fuselage has been heavily oversprayed in 65 or 76; a most unusual finish for this type of aircraft. While the fuselage cross has been toned down by over-spraying, the swastika is still black and retains its white outline*

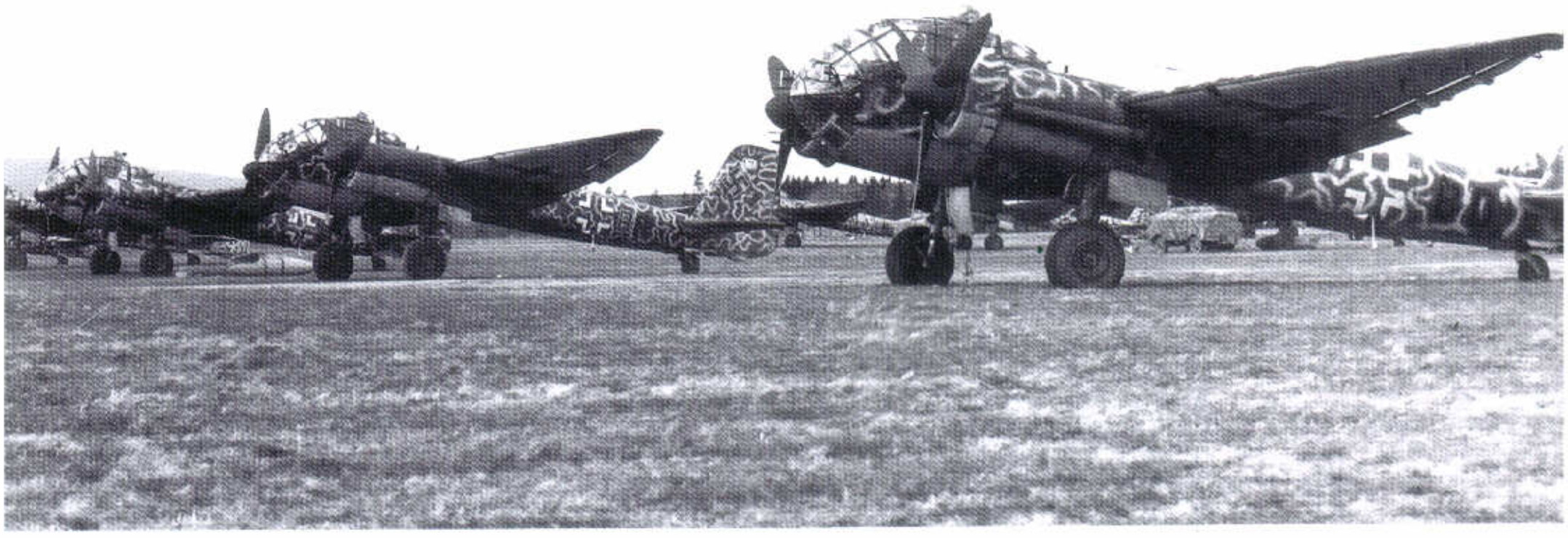


187: *These Junkers Ju 88As of 3./KGr 506, seen in late 1941, were probably finished in the all-purpose RLM 70/71/65 camouflage used by the majority of the bomber versions of the type. S4+AL is probably the Staffelkapitän's machine, with the 'A' outlined in yellow, the staffel colour. The nearer aircraft has white propeller spinners indicating I Gruppe*

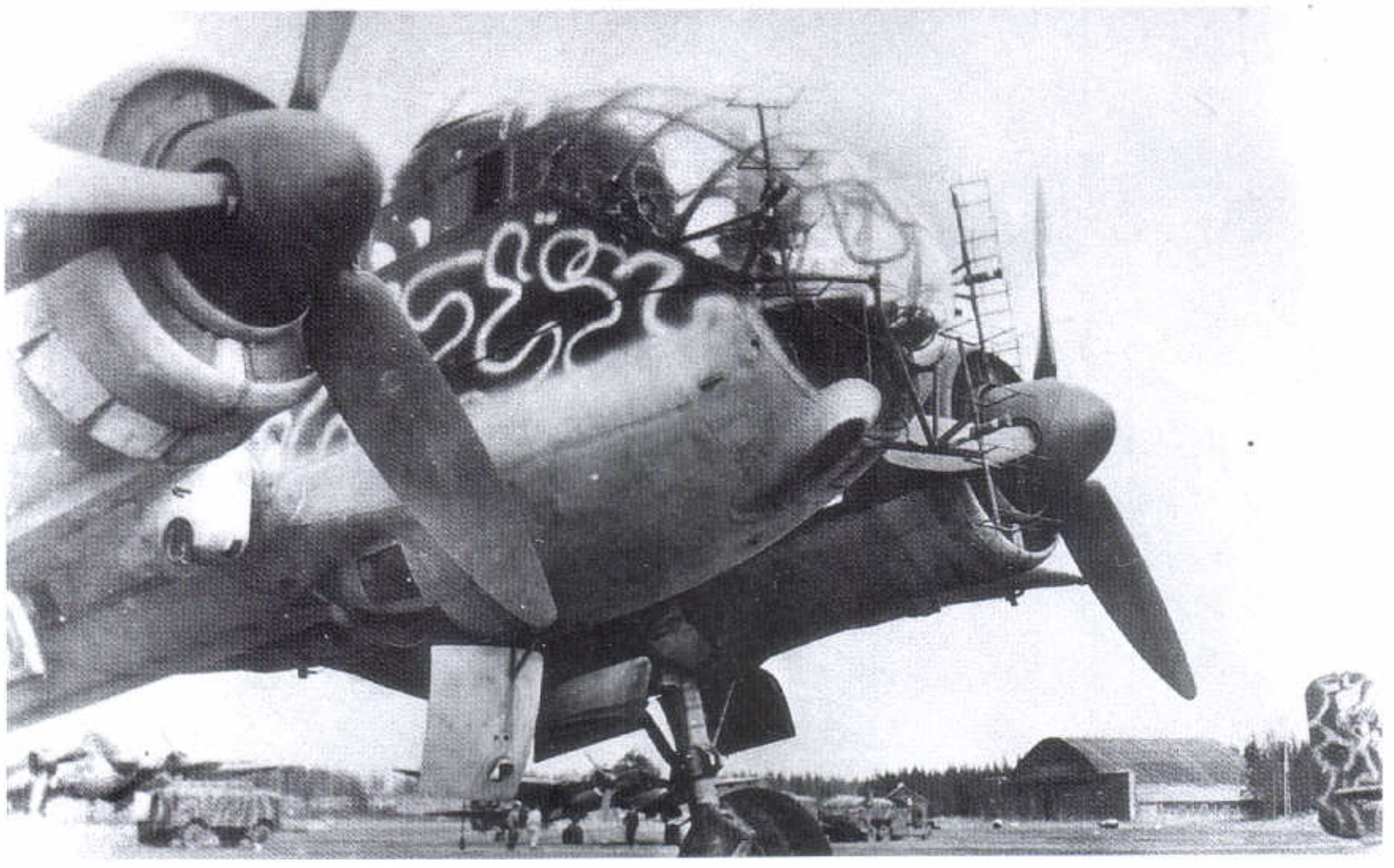
188 Below left: *Not quite what it seems, this Ju 188, WNr 190327, was captured by the RAF at the end of the war. As shown here, the German national markings have been re-applied on the photo. Once with III./KG26, 1H+GT, (yellow G?) was probably painted in standard 70/71/65 with a 'wave-effect' scribble of RLM 76 to better suit it for operations over water. The last three digits of the Werknummer are visible in white on the fin*



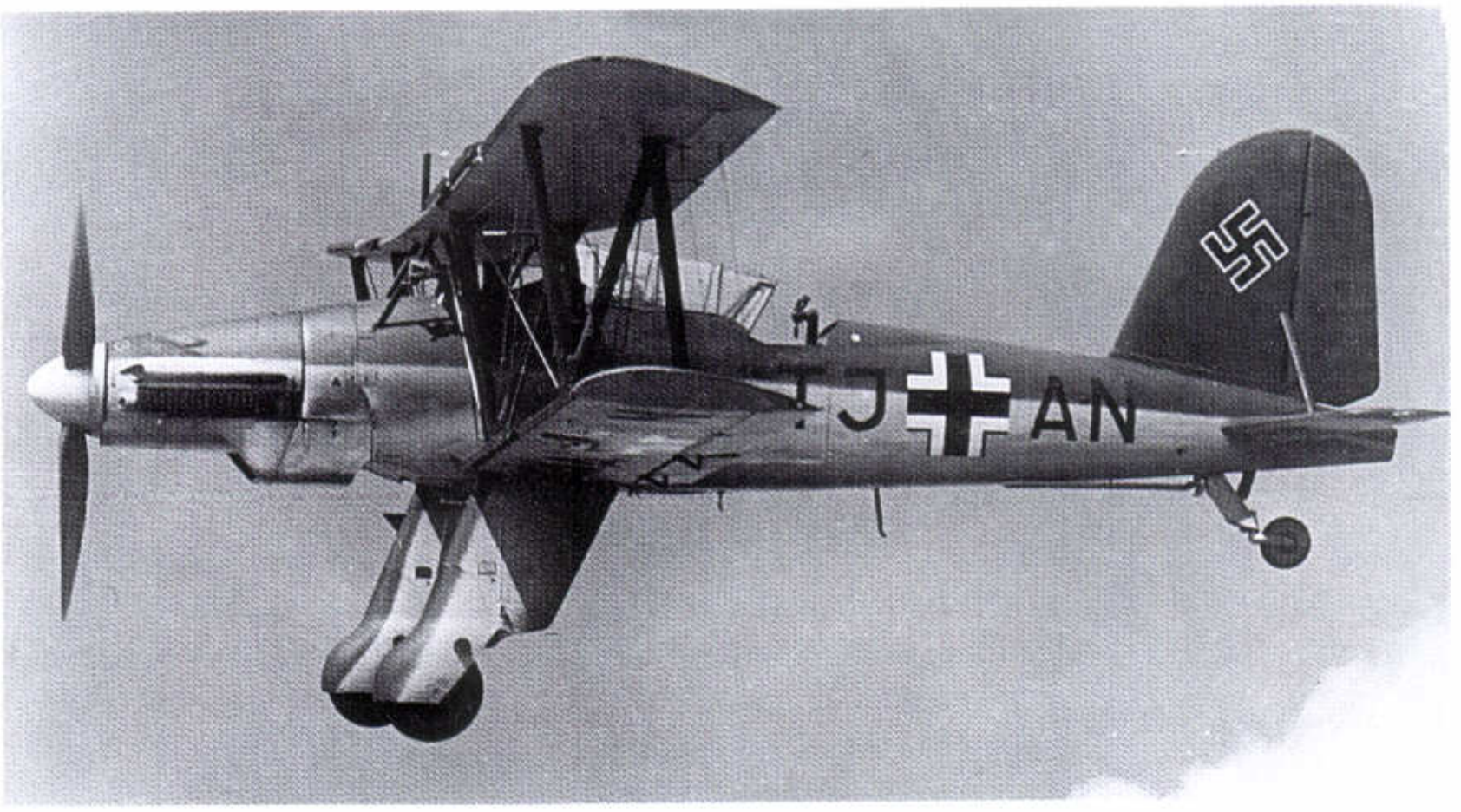
189 Below: *Ju 188A-3s of III./KG 26 (the aircraft being ex-Aufkl.Gr 124) at Gardemoen in Norway, May 1945. Nearest machine is G2+BD; next is G2+ BR, WNr 0608, the 'B' being outlined in yellow. All the aircraft seen here have had a scribble of 76 or 02 applied over their RLM 70/71 uppersurfaces*



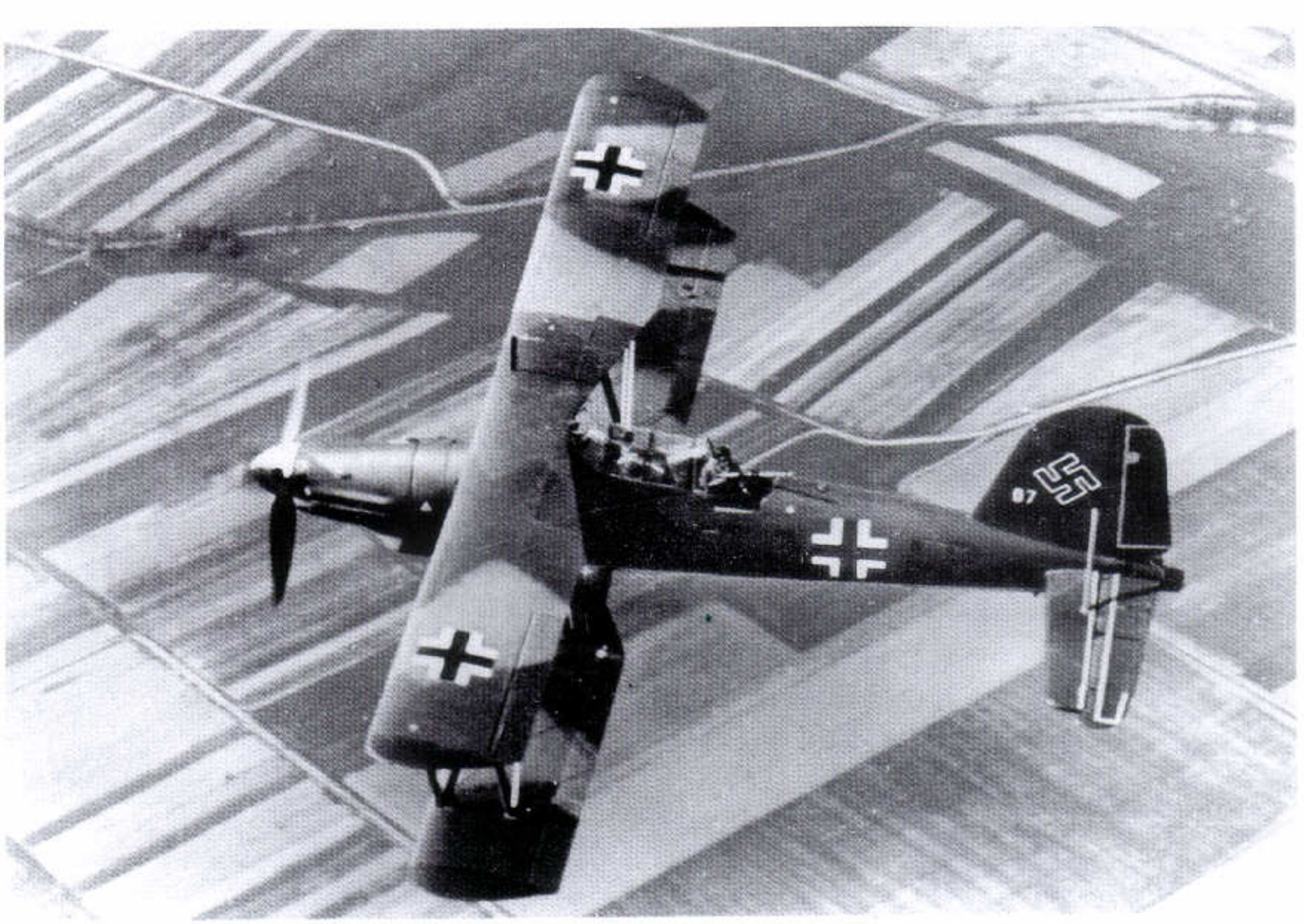
190: *Another of III./KG 26's torpedo-carrying Ju 188A-3s at Gardemoen in Norway, giving a good view of the RLM 76 scribble applied over the basic camouflage. Note that the 76 is lighter than the earlier RLM 65 undersurfaces, a typical deviation late in the war. Undercarriage legs are RLM 02, the wheel hubs and the cockpit interior are RLM 66 Schwarzgrau, while the propellers are entirely 70*



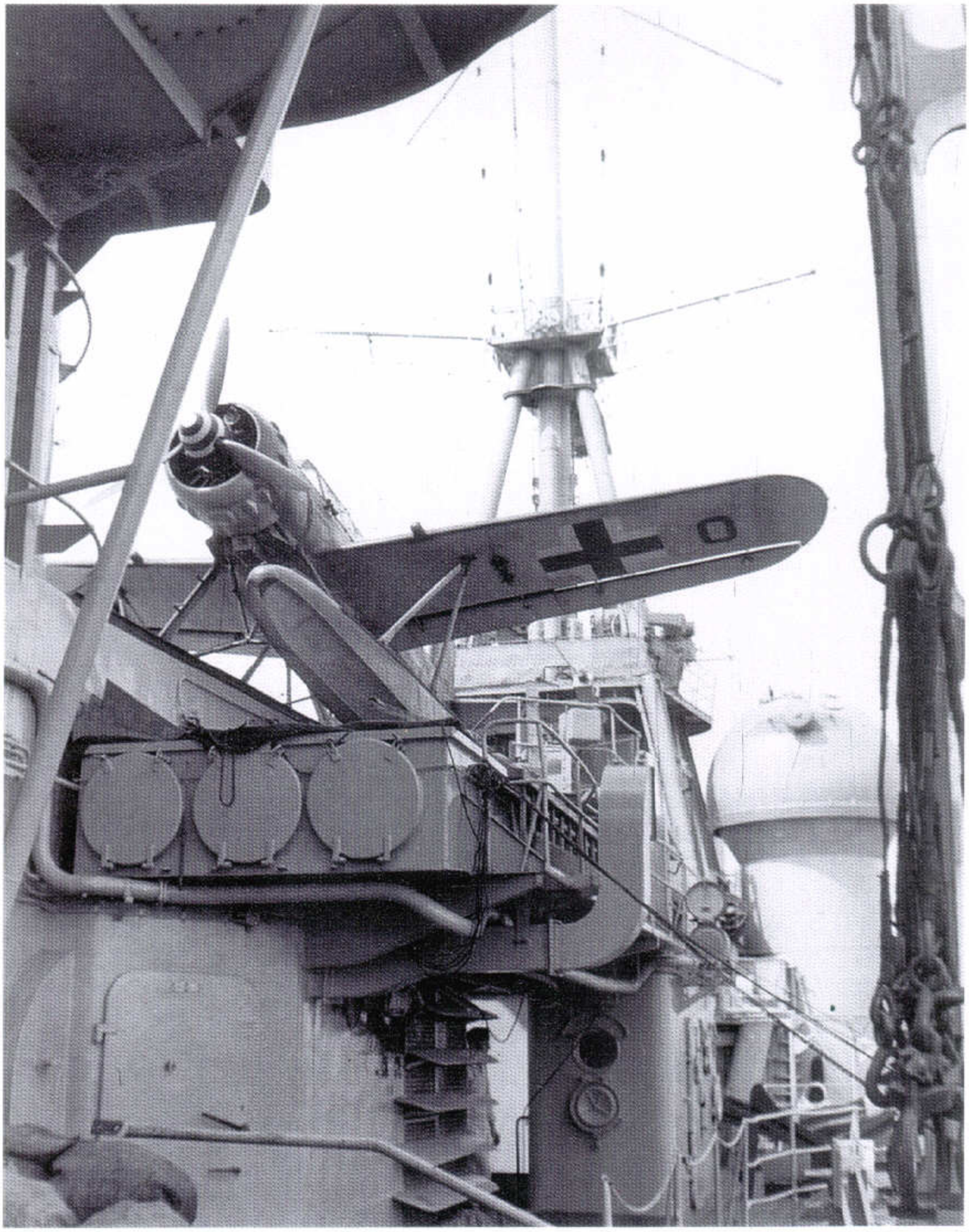
191: *The Fieseler Fi 167A-05, 'TJ+AN', in flight. In view of its intended carrier-borne role, the camouflage should be 72/73/65 but could conceivably be 70/71/65. The high demarcation line between the upper and lower surface colours is unusual, while the splinter pattern can be clearly seen on the fuselage spine. Balkenkreuz and swastika both have thin black borders. The propeller spinner is painted in white or possibly in Hellblau 65*



192: *This is the Fieseler Fi 167A-07, 'TJ+AP', under trial with the Erprobungstaffel 167 over Holland in spring 1942. It is apparent that the basic camouflage pattern has been modified by the addition of a light tone, possibly 02 or 76, evidence perhaps of experiments with sea camouflage. Twelve pre-production Fi 167s were built, most of which apparently ended up in Croatian air force service*



193: *Bearing the Stammkennzeichen 'TD+SI', this is WNr 871, the first of two Focke-Wulf Fw 190A-5/U14 torpedo-bomber prototypes. Differing from the standard model mostly in terms of undercarriage strengthening, an extended tailwheel and a larger fin, it appears to be finished in the standard RLM 74/75/76 fighter colours. Markings are entirely standard for the mid-war period*



194: *An unusual view of Arado Ar 196, T3+OM, of BFGr. 196 aboard the catapult of the Kriegsmarine heavy cruiser* Prinz Eugen *at her surrender in Copenhagen at the end of the war. Markings and camouflage of the Ar 196 remained much the same throughout the conflict. The major difference here is the white spiral on the spinner, which was required on all Luftwaffe operational aircraft as a recognition marking from 20 July 1944*

SNOW CAMOUFLAGE

The Luftwaffe in winter

As the war continued, the Luftwaffe also required camouflage for snow-covered landscapes. Luftwaffe Directive Sheet 27, issue 21 June 1943, contained the following instructions:

"**Snow camouflage for aircraft**

The Ikarin camouflage paint A2515.21 as used last winter for snow camouflage of aircraft should in future be indented for only under the designation Aircraft paint 7126.21. A TAGL (Technical Directive, Director General Procurement and Supply) with user's instructions will be available from GL/C-TT."

Luftwaffe Directive Sheet 43, issue 4.10.1943, provides further information:

"**Paints for winter camouflaging aircraft and equipment**

1. Aircraft

In accordance with TAGL I Q 2e No. 1, serial number 437/43, the following is to be used for the winter camouflage (white camouflage) of aircraft and aircraft equipment, provided such latter is fitted to the aircraft or protrudes from it (e.g. on-board armament):
Camouflage paint, white aircraft paint 7126.21

2. Protective covers

For anti-icing covers (snow and frost covers for wing and tail surfaces), as well as aircraft tarpaulins, aircraft paint 7126.21 is also to be used (TAGL I Q 2e No. 4, serial number 549/43).

3. Equipment

For vehicles, ground equipment and other equipment (guns, cross-country vehicles) the following should be used:
Re-camouflaging paste, white, as per TL 6355"

The two Luftwaffe Directives quoted above illustrate that – after the experiences of the winter of 41/42 – a ready-use product for camouflaging aircraft and equipment had been made available for the winter of 42/43. The Ikarin camouflage paint was subsequently standardized and given an aircraft paint number which simplified procurement by the RLM and ordering by the units. Furthermore, it is interesting to note that, in addition to the aircraft themselves, the protective covers for the machines were also to be painted with aircraft paint 7126.21.

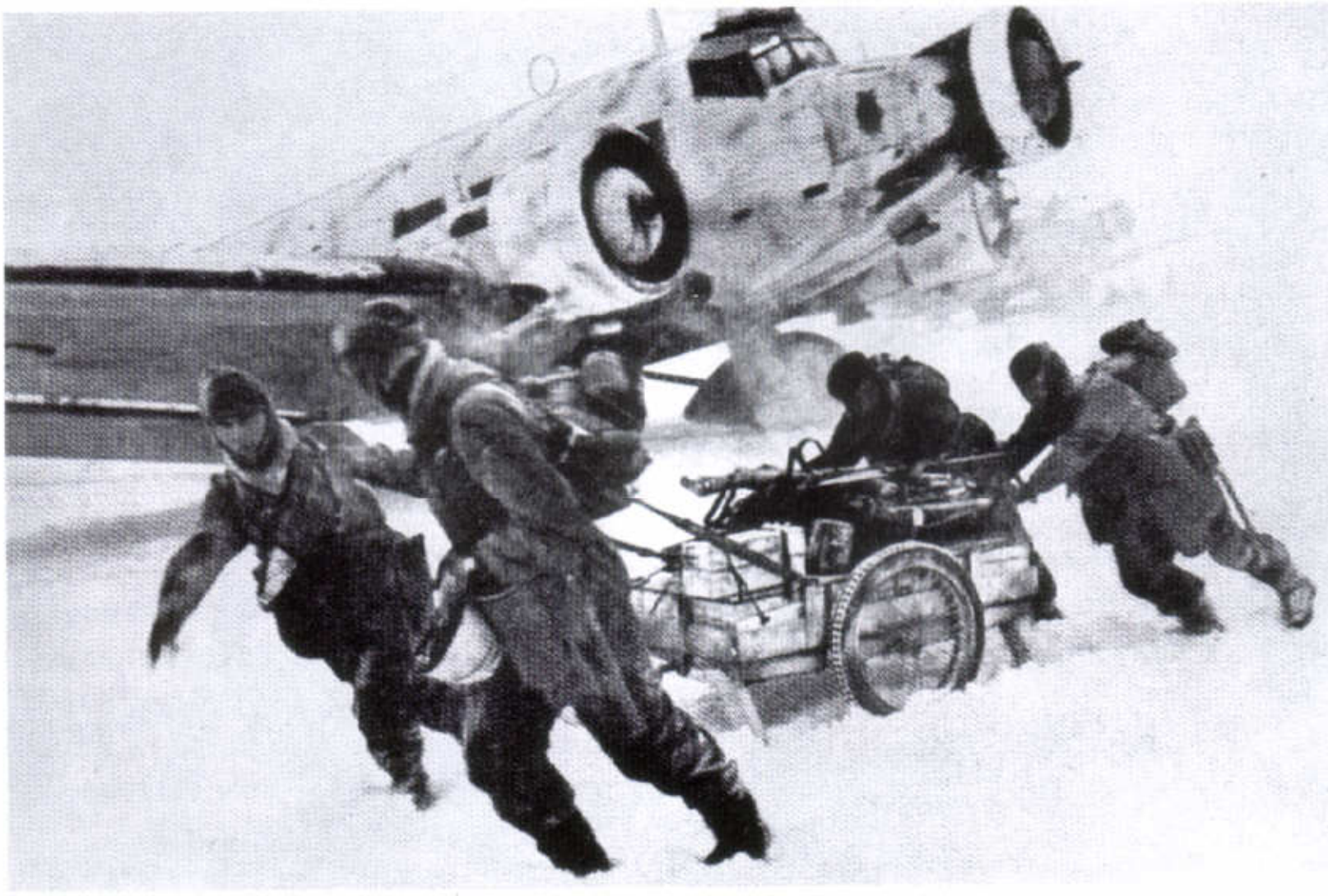
195 Above: *A Junkers Ju 88D, probably F6+DK or F6+DN, of (F)/122 in Russia in winter 1943. The aircraft wears a well-worn winter camouflage over the standard 70/71/65 camouflage. All visible national markings are the 'mid-war' style with thin black border. Although the fourth digit of the unit code cannot be seen in its entirety, it is almost certainly as indicated on account of the Rot 23 spinners, (compare with the Gelb 04 fuselage band) indicating ownership by either 2. or 5. staffel respectively*

This aircraft paint was used to provide a permanent finish (see also aircraft paint number with night-camouflage finish in chapter 6.3.4, 7 and 15). The paint could be applied by brush, broom or by spray gun. Execution of the work was left to the units themselves, who were responsible for carrying it out according to their own requirements. The book *Der Flugzeugmaler*, (The Aircraft Painter) 1944 edition, states the following regarding winter camouflage:

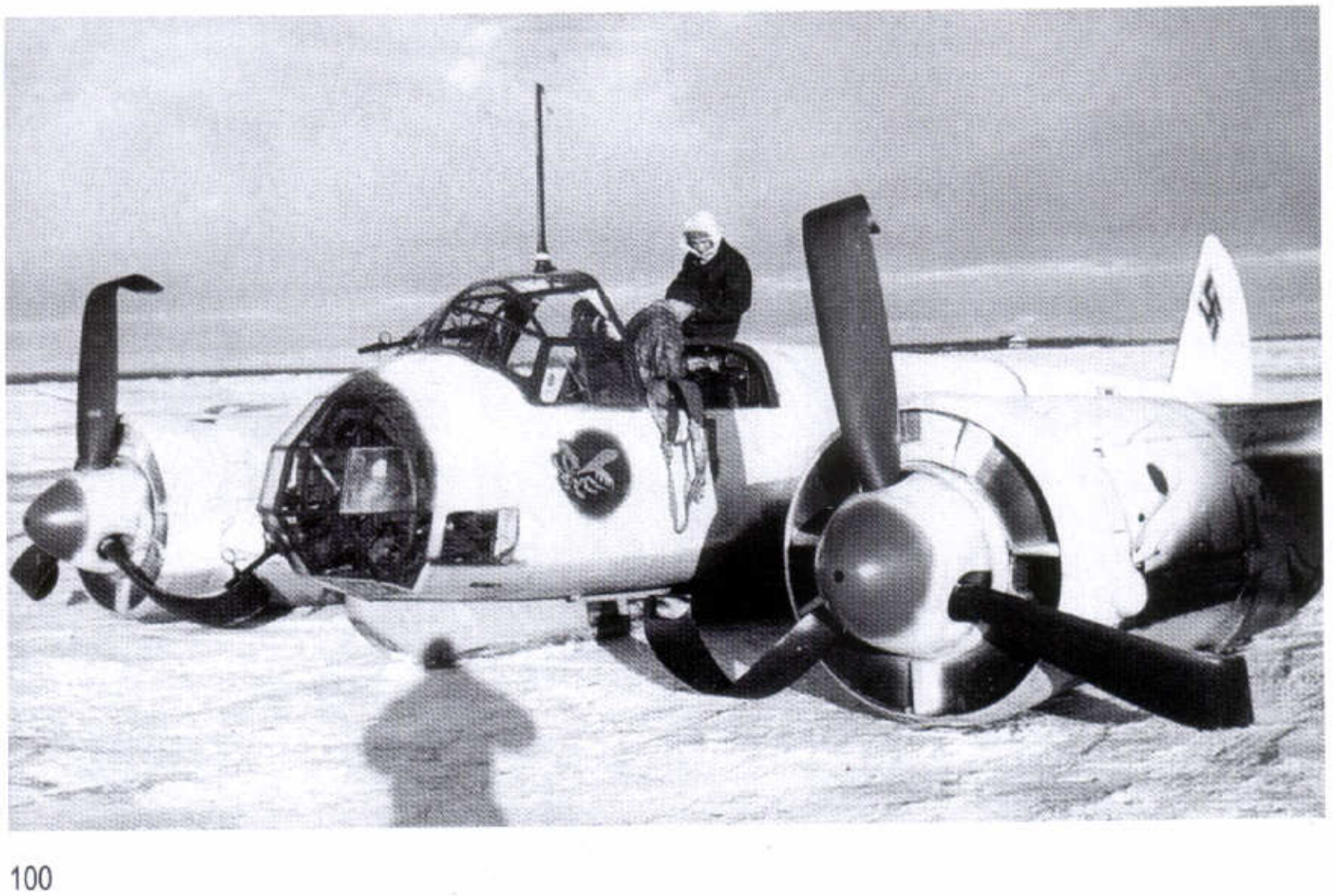
> "Snow camouflage is applied in the winter months only, with aviation lacquer 7126.21. Paintbrushes are best used to apply the colour. Only the upper side of the aircraft and the upper fuselage are camouflaged, down to the light blue paint on the underside. The wing and fuselage markings must remain visible."

This camouflage was not described in L.Dv 521/1 of November 1941. As the winter camouflage patterns were not fixed, all conceivable variants existed depending on the unit applying it, from a complete, permanent upper surface coating through splinter schemes to sprayed-on meandering designs which were also applied in removable paints.

Instructions also exist that aircraft produced, maintained or overhauled during the winter months had to be returned to Eastern front units with a solid white coating by the factory or maintenance workshops. This solid coating was then repainted in the customary camouflage by the units concerned when necessary.

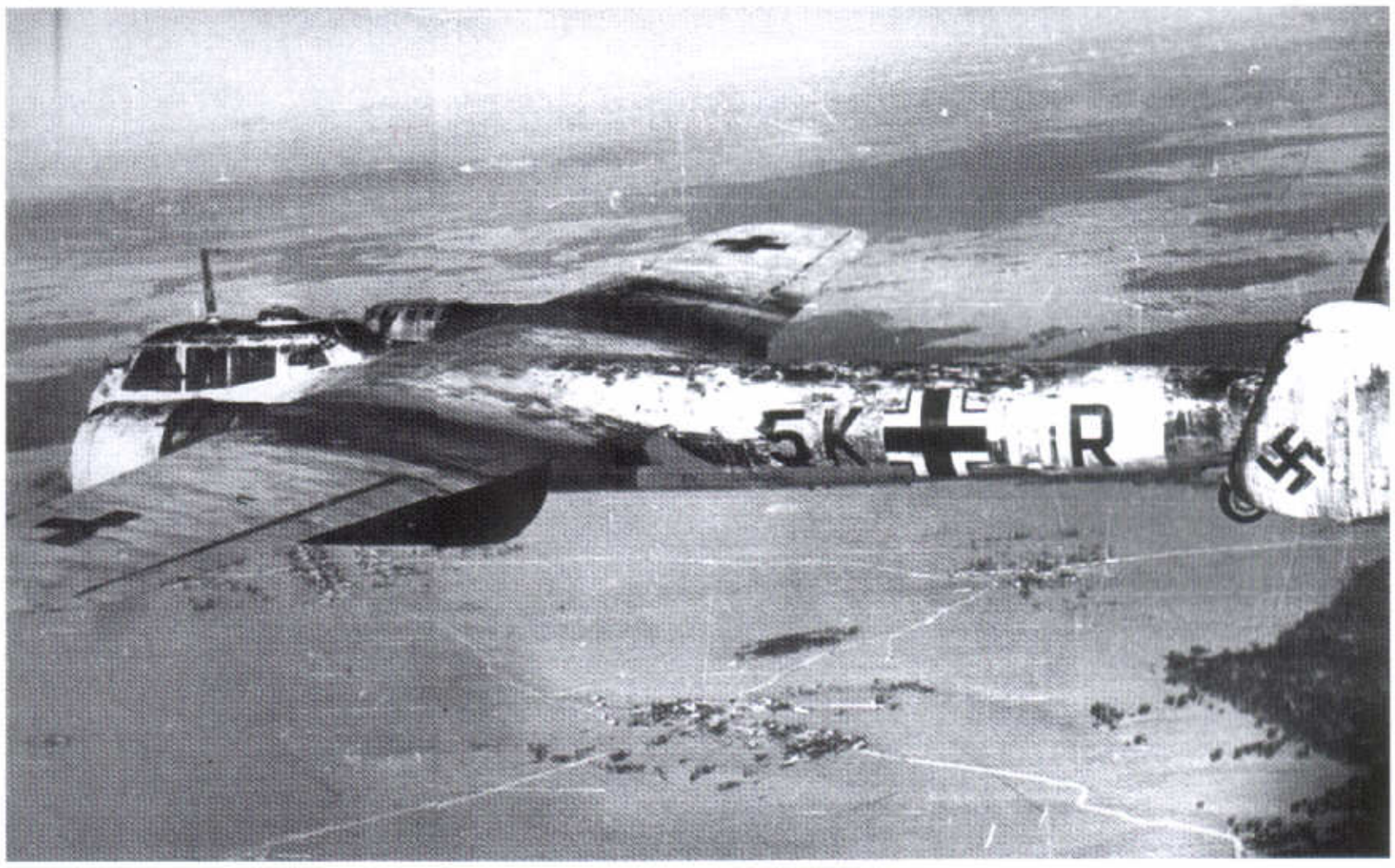


196: *Ground troops unloading a Junkers Ju 52/3m, probably from BFS 2, whose pig emblem can be just made out forward of the cockpit, in a typical Eastern Front winter setting. The aircraft wears a thinly applied coat of temporary white paint, either Ikarin A2515.21 or 7126.21. The paint is already wearing away from the leading edges of the wings. As the losses mounted in the east, many experienced crews and instructors from the flying schools were pressed into running aerial supply missions*



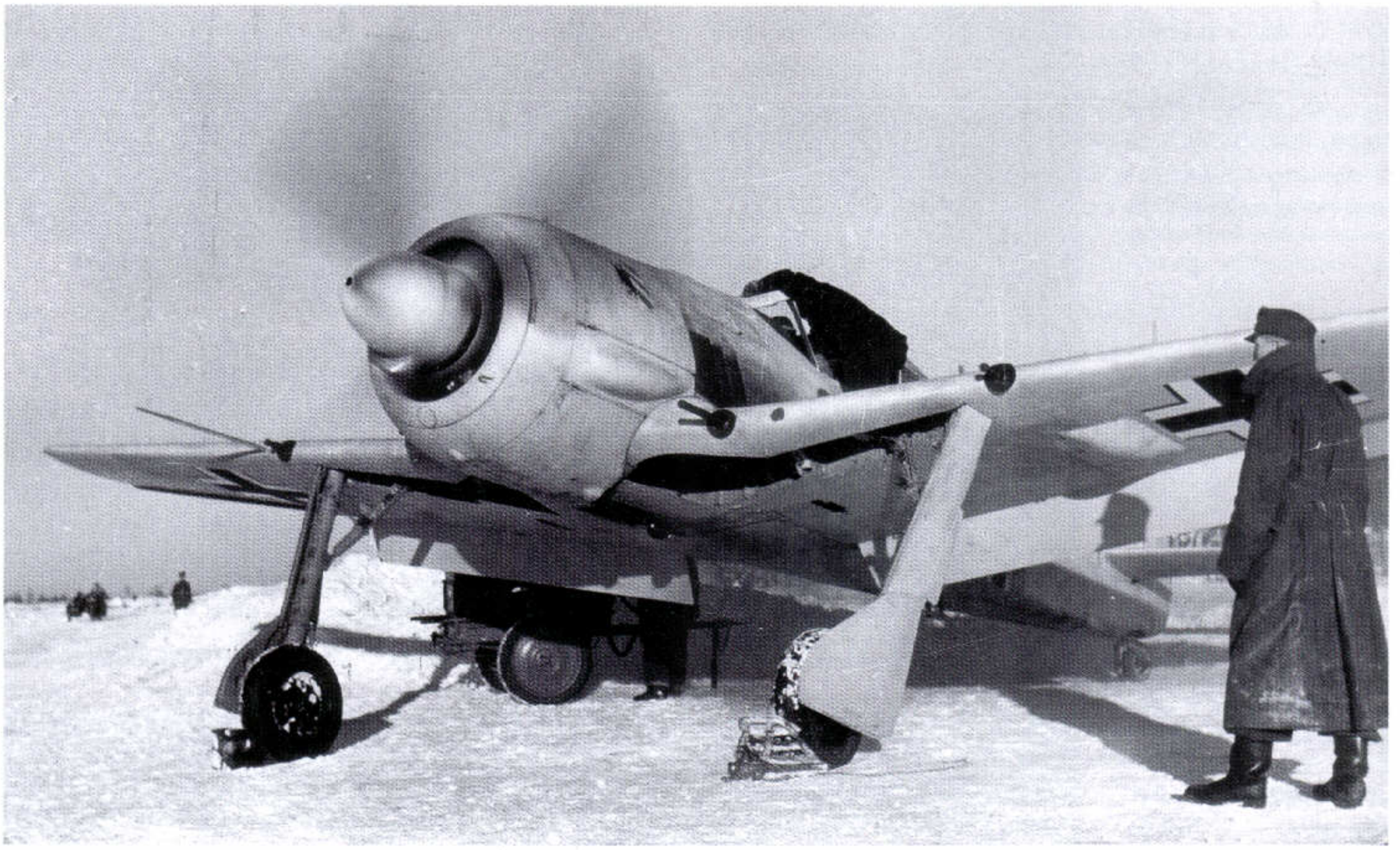
197: *Crashlanded somewhere in Russia in winter 1941-42, this Junkers Ju 88A-5, F1+AS, of 8./KG 76 wears very clean Ikarin A2515.21 temporary snow camouflage on the upper-surfaces. Despite instructions that the temporary paint was best applied by brush, it is obvious that in this case a spraygun has been used. Care has been taken to avoid covering the unit emblem and the Rot 23 propeller spinners. The painter has, however, oversprayed the radiators*

198: *In the case of this Dornier Do 17Z of 7./KG 3, 5K+HR, it is apparent that the temporary snow camouflage has been applied as per instructions, by brush. Wear and weather, however, are already washing it off, adding to the camouflage effect*



199: *'Yellow 12', a Bf 109F-2 of 3./JG 51 on the Eastern Front has received temporary white camouflage applied by brush, as per instructions, carefully avoiding the swastika and yellow theatre band. Contrary to regulations, however, the upperwing Balkenkreuz have been obscured. Note the warm-air blower on a sledge, needed to pre-warm the engine before it could be started*

200: *Pictured in the winter of 1942-43, this Messerschmitt Bf 110E-3 of Aufkl.Gr(F)/33 (possibly 3. Staffel) has been recently finished in temporary white snow camouflage, applied by brush. Yellow undersides to the engine cowlings have also been recently applied, note the contrast between the underside RLM 65 (or 76)*



201 Above: *An Fw 190A-4 of I./JG 54 starts up at Siverskajya in winter 1943. The spray painter has given a slightly mottled effect to the temporary white finish which enhances the camouflage effect. It can be seen that the wheel bay, wheel cover interior and landing gear were painted in 02*

202 Left: *Another Fw 190A-4 of I./JG 54 has a more mottled effect to its snow camouflage. Such a finish could only be applied by spray gun. Note the yellow wingtip and apparent absence of a fuselage band*

203: *A pair of Fw 190F-8/R1 fighter-bombers of SG 2 in Hungary in early 1945. The winter camouflage on the nearest aircraft has been hastily applied in stripes and is heavily weathered. Armed with an AB250 bomb container, the machine shows signs of the shortages which were beginning to afflict the Luftwaffe at this stage of the war; the underside appears to have been left unpainted, as does the engine cowling which has several dents in the bulge over the air intake. The cowl ring may be yellow. Note the maximum simplified Balkenkreuz*

204: *A Dornier Do 17Z of the Croatian-manned 15./KG 53 in the winter of 1941-42, taken on the Russian front. The removable winter camouflage is very clean and has obviously been applied correctly by brush. Unusually, the Ikarin paint has been carefully applied to the cockpit framing. At points subjected to heavy use the underlying 70/71 has started to reappear. The propeller spinners are divivded into two colours; white and possibly green or blue to identify the V Gruppe; the colour seems too dark for yellow which would be the staffel colour. Note the Panje horse and sledge*

205: *Another aircraft of KG 53. In this case an He 111 of 9 Staffel, probably the Staffelkapitän's machine, coded A1+AT. The temporary white finish is heavily weathered and the underside looks extremely dirty. Spinner tips and individual aircraft letter 'A' are yellow, the staffel colour*

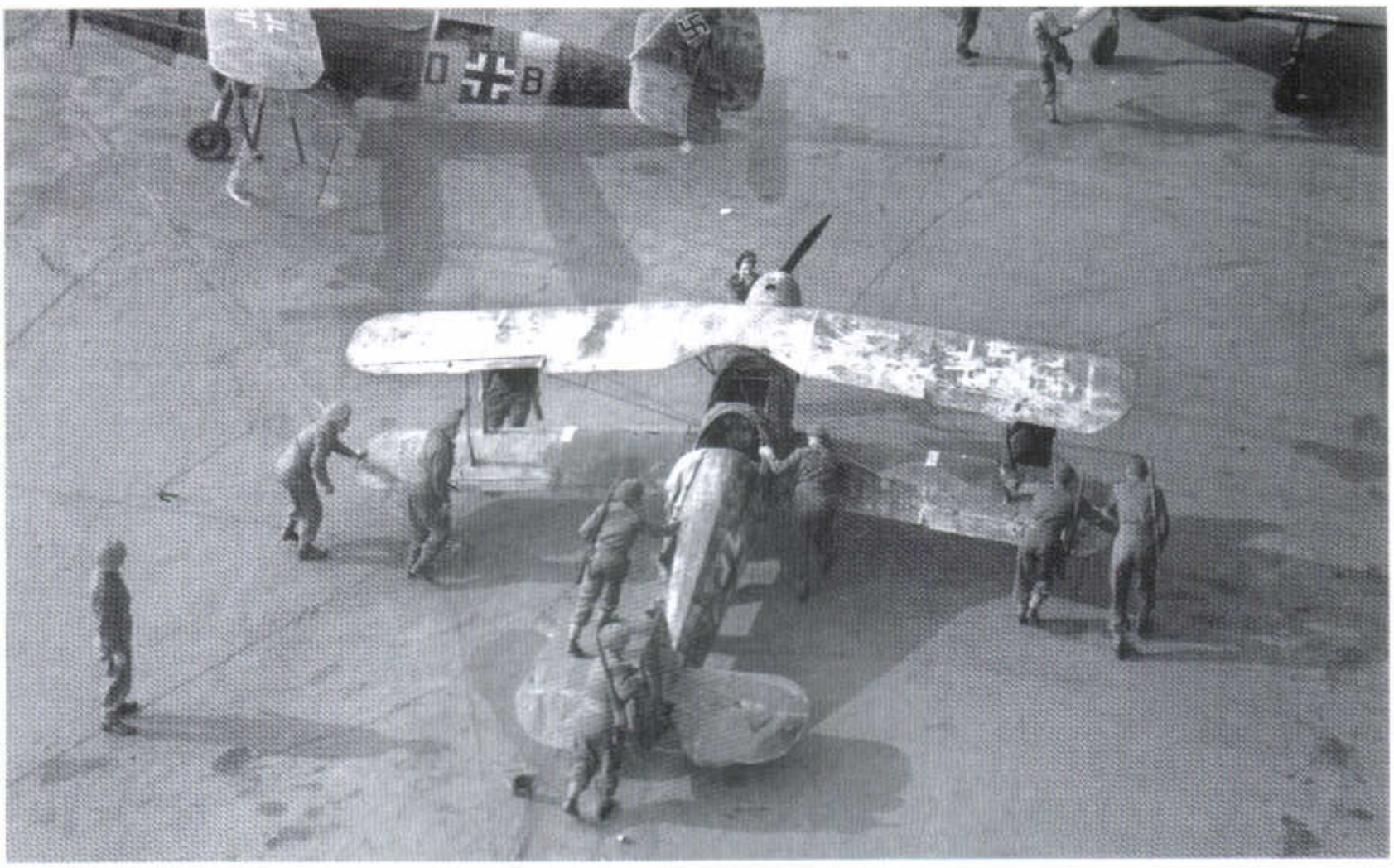
206: *Not only landplanes received winter camouflage. This is BV 138C-1 WNr 0311039, 6I+KK, of 2.(F)/SAGr. 130 at an Arctic Ocean refuelling rendezvous with two U-boats (U-255 and U-601) off Sporyi Navalok on the east coast of Novaya Zemlya between 4-20 August 1943. As both the boats and the aircraft used diesel engines, the U-boats were able to refuel the aircraft. Needless to say, the washable white paint had only a short life in these conditions. Note the FuG 200 radar antenna projecting from the wing leading edge*

207: *A Focke-Wulf Fw 189, 'P', of an unidentified unit in full winter camouflage on a snow covered airfield. It is apparent that the temporary white finish is already wearing. The aircraft has yellow wingtips and a band on the boom, just forward of which is the letter 'P'. All visible Balkenkreuze are from the 'mid-war' style with thin black borders*

208: *This Henschel Hs 126B-1 of Aufkl.Gr(H)/12, 'H1+MK', has had the temporary winter camouflage roughly applied by brush with all national and unit markings left clear. As usual, the finish is rapidly wearing away where it is exposed to the dirt thrown up by the landing gear and the ground crew clambering over it. The yellow fuselage band is rather wider than required by regulations and the unit code is oddly spaced*

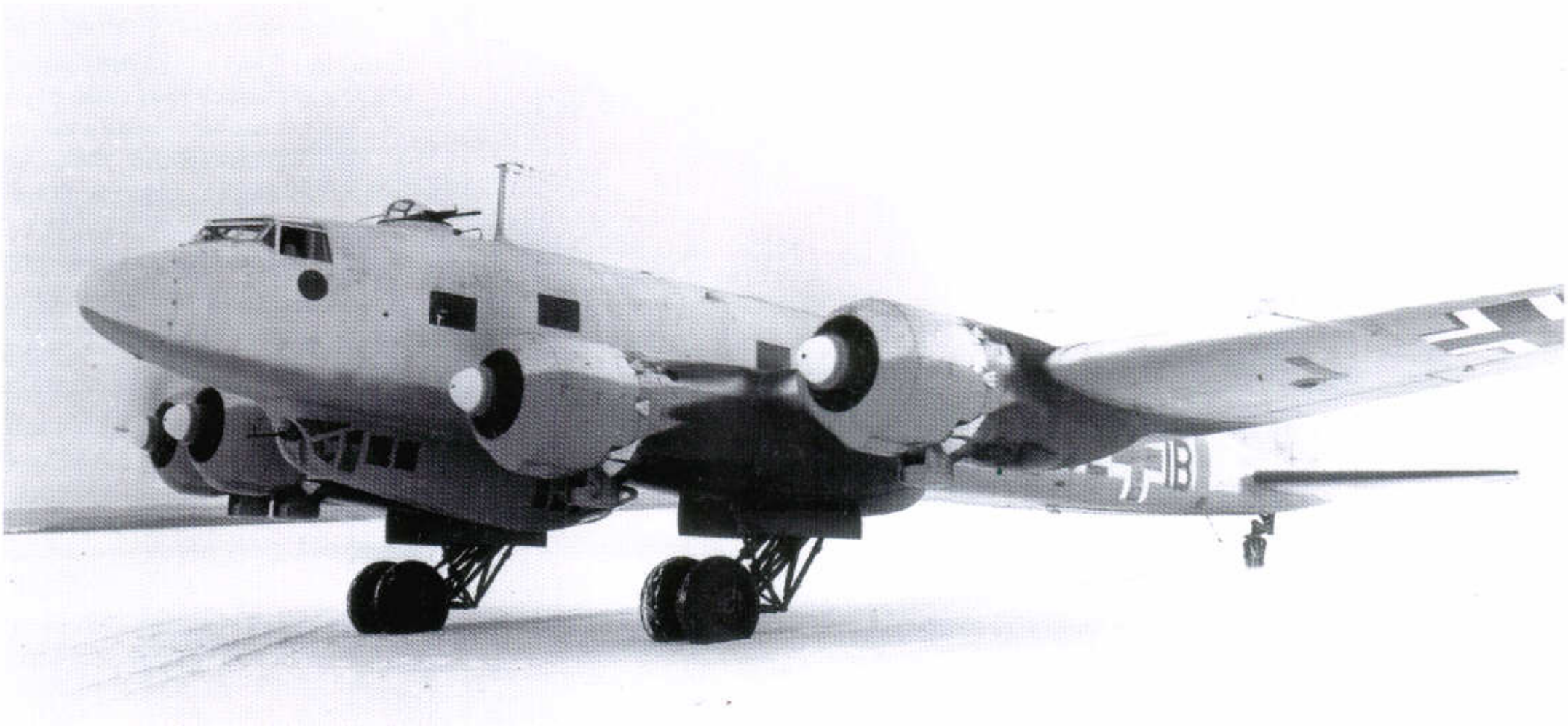
209 *Seen in the bitter winter of 1944-45 in East Prussia, this Fieseler Fi 156C-2 has had its winter camouflage applied thickly around the centre fuselage; everywhere else it is wearing away to reveal the 70/71 camouflage beneath. Oddly, despite the late date in the war, the markings are the same as two years earlier. The last two letters of the code have apparently been re-applied at some point out of alignment with the rest. Note also that the yellow fuselage band is also flaking away*

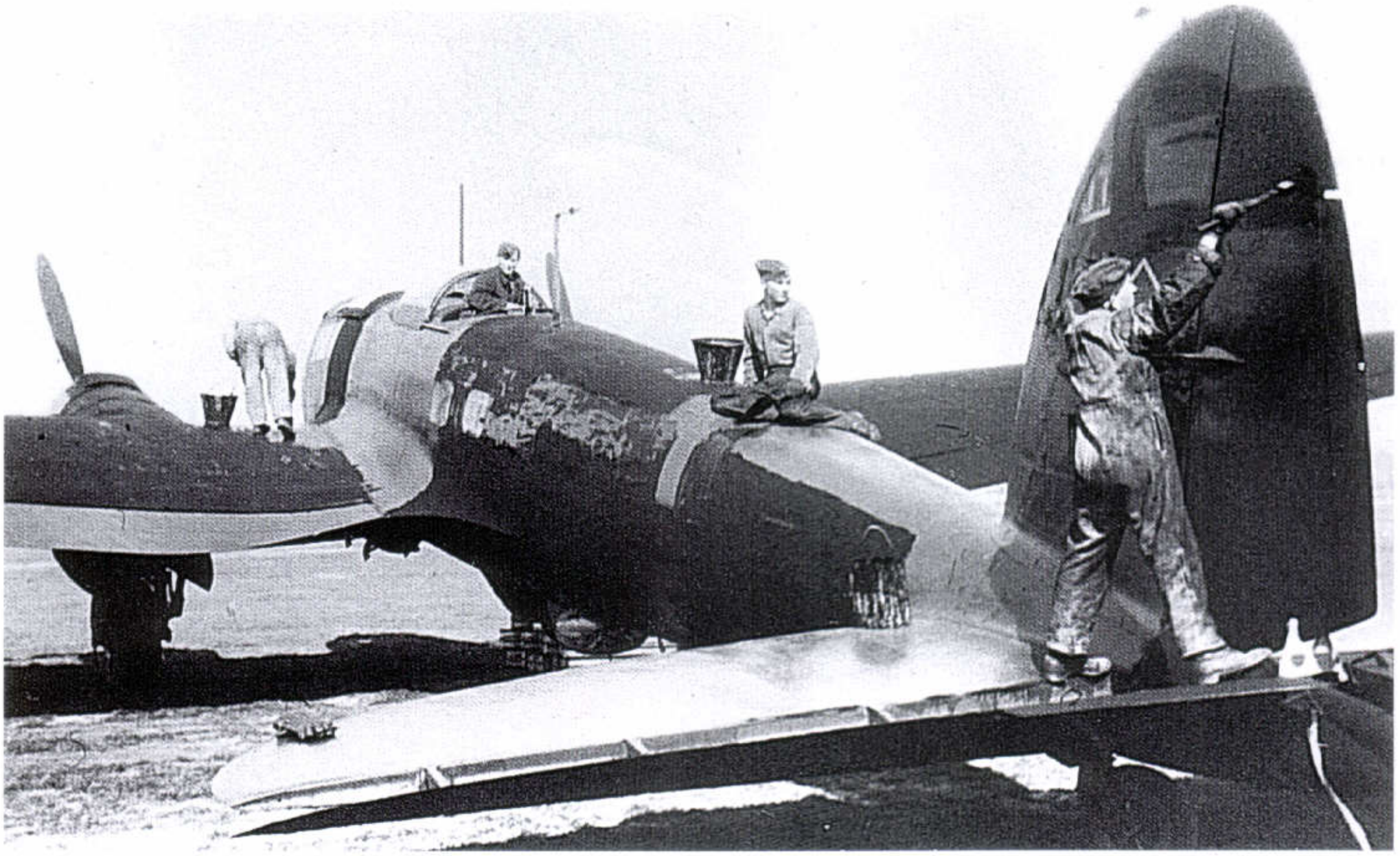
210: *British troops moving a captured Bücker Bü 131 trainer, GD+OH, which wears the vestiges of winter camouflage. Underneath appears to be a single dark green. Note the maximum simplified Balkenkreuz on the upper wing and the earlier style on the fuselage. The purpose of the white stripes on the lower wings is unknown. Behind is a Gotha Go 145, WNr 1258, TD+BA, finished in a green mottle over the basic grey. The two yellow fuselage stripes indicate it was a blind-flying trainer but the panel over the rear cockpit may indicate it was used as a single-seat nuisance bomber*



211 Right: *An extremely dirty Fw 190F-8/R1, probably from SG 2 in Hungary in 1945 as a portion of the 04 underwing chevron used by ground attack aircraft operating there at the time can just be seen. It is painted in 74/57/76 with a sprayed cover coat of winter camouflage. The fuselage cross is from the 'mid-war' style with black border, indicating that the aircraft is relatively old since this style of Balkenkreuz was never used after mid-1943*

212 Below: *Fw 200C-4/U1, WNr 0137, CE+IB, in winter camouflage, was the Führer's personal transport. Note the brilliant white spinners*





NIGHT CAMOUFLAGE

"Darkness brings not sleep"

The Battle of Britain soon established that without fighter escorts German bombers were at the mercy of British fighters when flying over Britain during the day. Luftwaffe bombers were therefore obliged to resort to mostly night flying by the middle of 1940.

A night camouflage, RLM 22 Schwarz, was consequently introduced for this purpose.

On 16 July 1940, the Luftwaffe General Staff ordered the application of night camouflage paint:

"Genst. 6. Abt (IIIB) Nr 7797/40. Secret.

To achieve a high degree of camouflage against searchlights by applying a night camouflage paint, the aircraft's wing undersides, fuselage undersides and sides, including tailplane, must be overpainted with said paint, including all markings. The only exceptions are the Balkenkreuze on the uppersurface of the wing for national identification. It is essential that the overpainted Balkenkreuze can be restored by merely washing off the camouflage paint.

As far as those aircraft intended for night operations are not yet camouflaged as described above, this should be done immediately. It is also brought to the attention of all concerned that prior to applying the camouflage paint the areas to be painted must be given a coat of insulating lacquer."

This variant night camouflage was described in great detail in the November 1941 edition of L.Dv 521/1 (see page 224). It consisted of a permanent and a removable component, to make it easier to re-camouflage the aircraft for daytime operations.

The provisions for marking aircraft for night use were similarly highly detailed. A new shade was introduced with the L.Dv 521/1 of November 1941 for night camouflage markings:

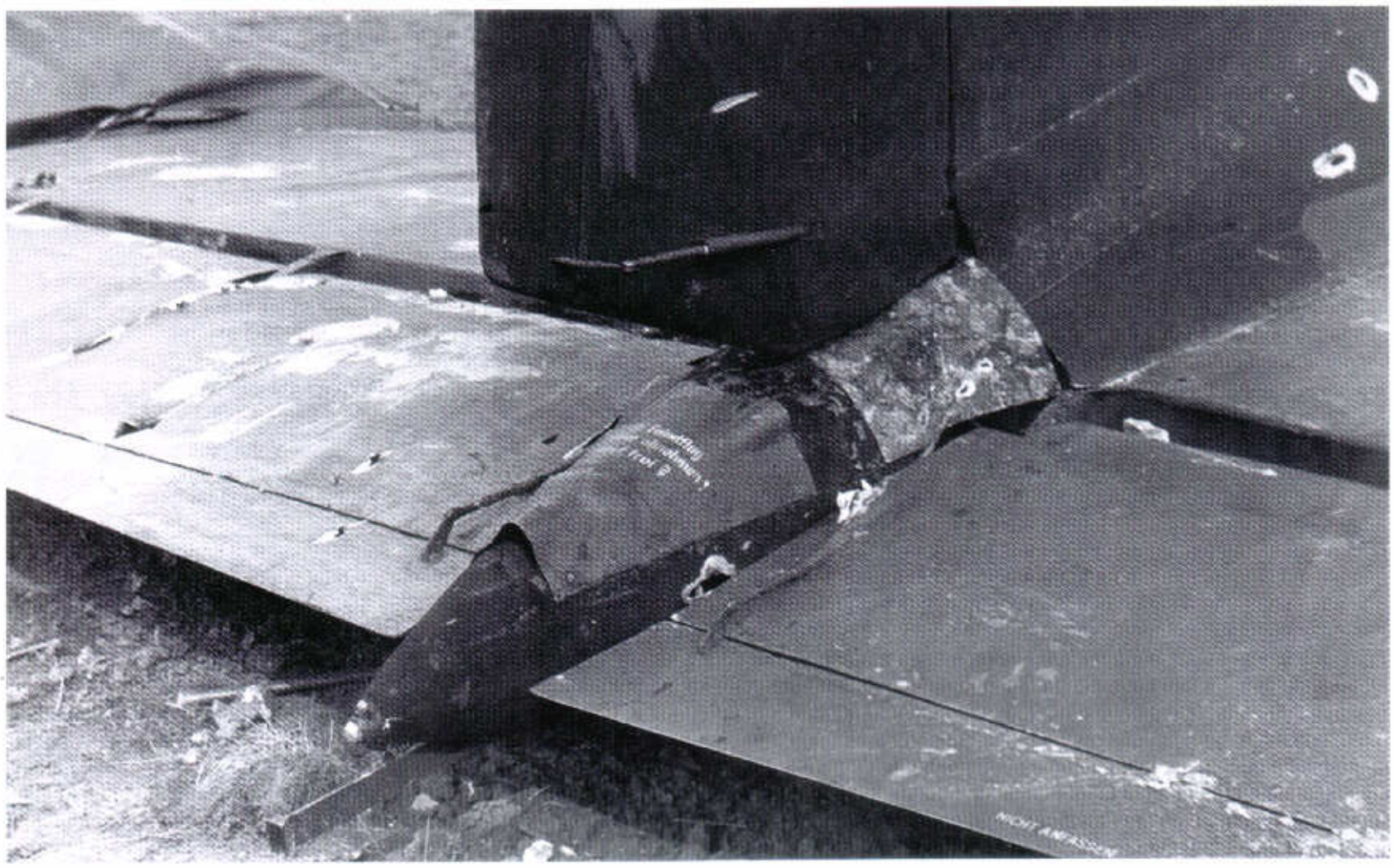
RLM 77	Hellgrau	Light grey

This semi-permanent, semi-removable night camouflage was used up to 1943. As daytime bomber operations became ever more hazardous, a permanent night camouflage was introduced at this point. An advantage was its lower air resistance as against the removable night camouflage.

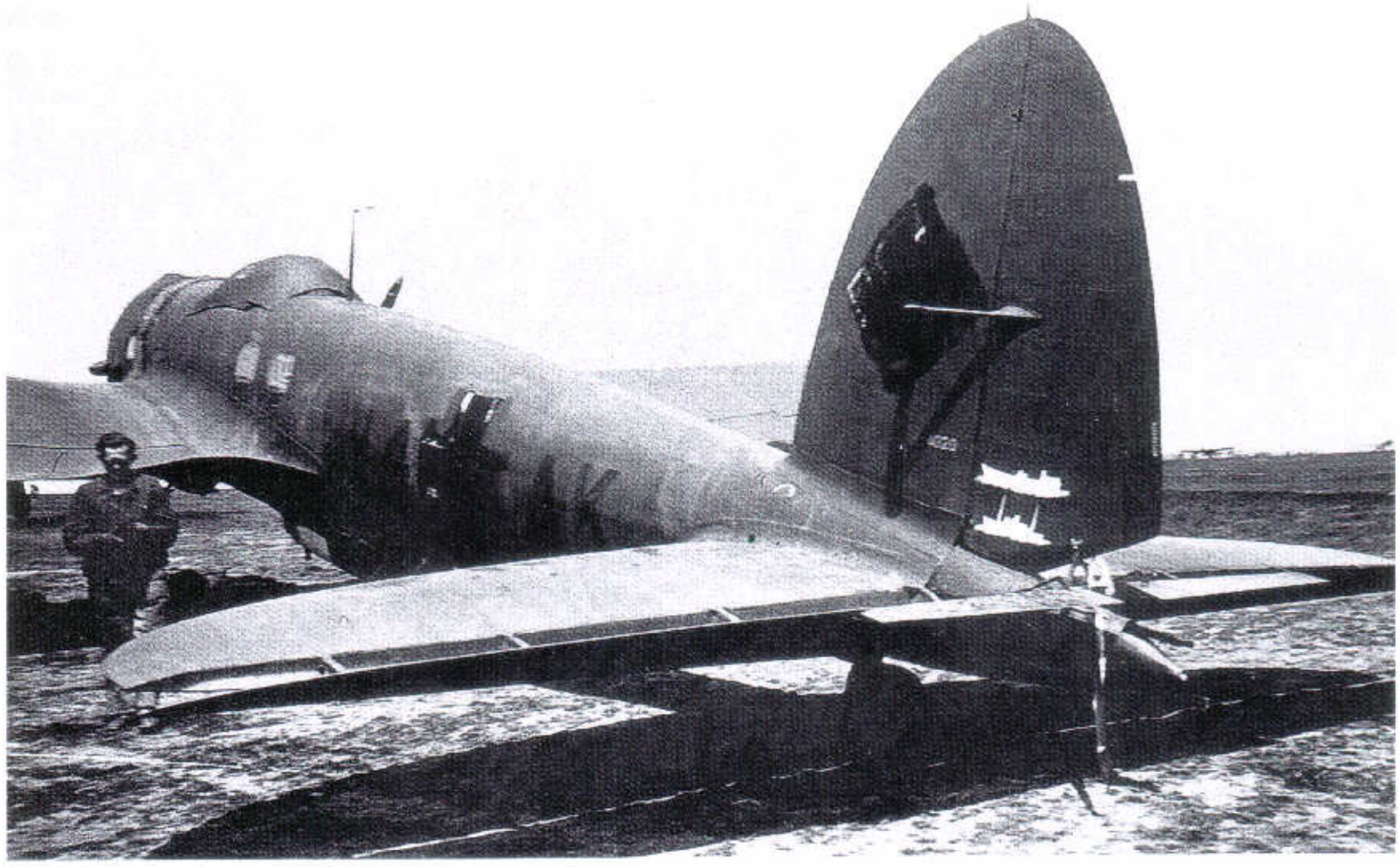
213 Above: *Ground crew hard at work applying temporary RLM 22 black camouflage paint to an Heinkel He 111 of 9./KG 26, all in accordance with the official instructions, except that the men are clearly intent on covering the wing uppersurfaces also. There was meant to be an overlap of 500mm onto the wing leading edges but here the paint has spread rather further... The code letters, 'JT' can just be seen on the fin*

214: *This anonymous He 111, 'M', wears only the white portions of the national insignia on its solid dark finish. Its most interesting feature is the permanent 7124.22 Schwarz night camouflage paint applied in accordance with instructions to the wing leading edges and centre section.* *See page 227*

215: *This closeup of the tail of He 111H-5 WNr 3924, 5J+JR, of 7./KG 4 which was shot down near Maidstone on 20 April 1941, clearly shows the sooty finish of the temporary 7120.22 night camouflage paint. By comparison, the smoother finish of the 70/71 greens permanent camouflage paint is clear. The small lettered fairing was meant to cover a rearward firing 'scare' gun which was occasionally fitted to He 111s. Note the instruction on the trim tab: 'Nicht Anfassen' - 'Do not touch'*



216: *Heinkel He 111H-6, V4+AK, WNr 4020, of 2/KG 1, probably seen while the unit was based in France in late 1940. In accordance with the official instructions, all national insignia have been overpainted with the temporary black. In later times these would be re-applied in 77.* *(See page 225).* *The two ship silhouettes indicating kills on the rudder have been left alone. Strictly speaking the temporary black should have been brought up to the top of the Balkenkreuze. On this machine the rearward firing gun is still in position in the extreme tail (compare with photo 215)*



3. Paint and Markings

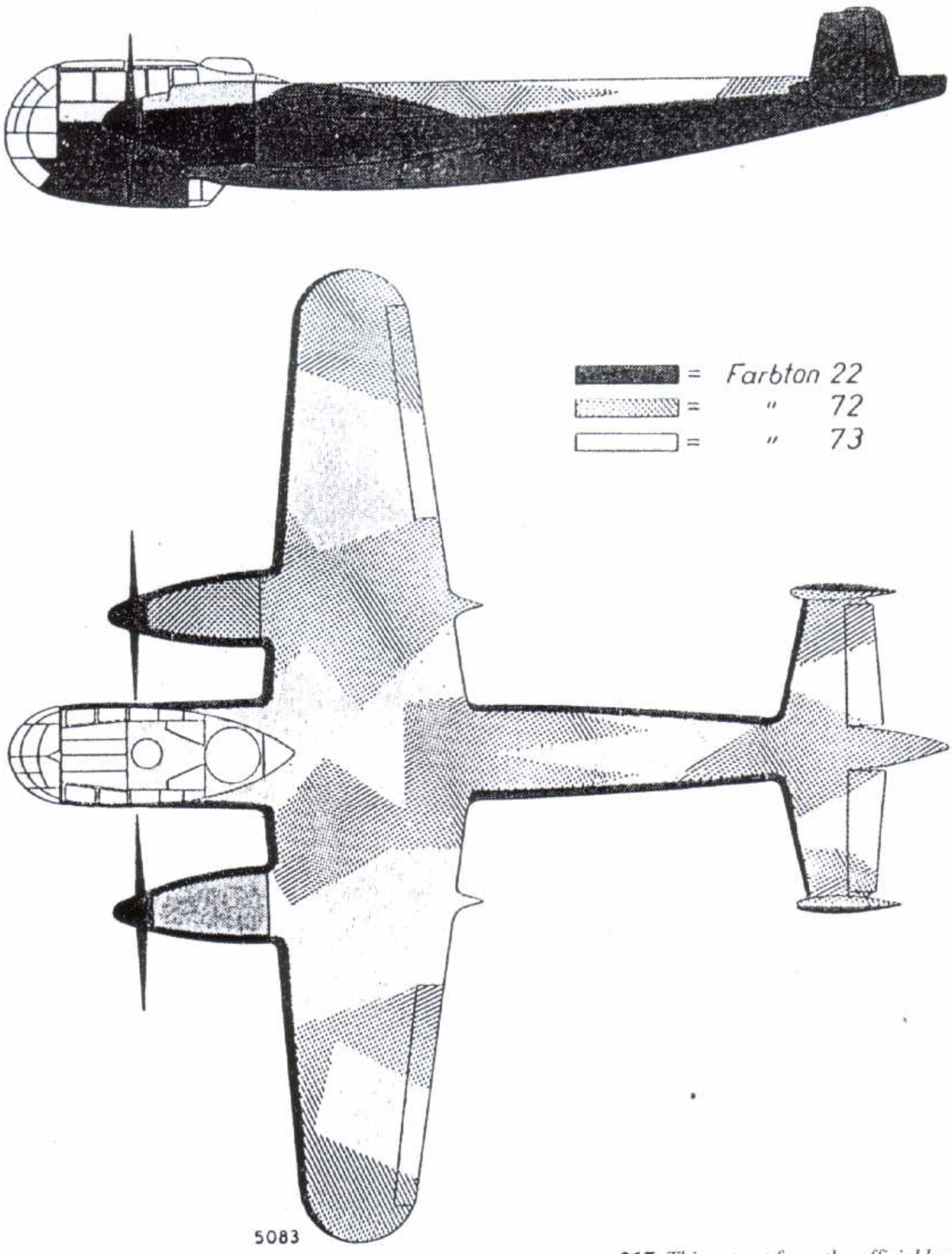
a. Paint and camouflage

Camouflage paint is applied according to drawing 217 M-1 p. 9 (Fig. 12 below), from which measurements may be obtained, tolerance up to 5%. The aircraft and its parts are painted at the works in accordance with DoV 1728.

Paint:

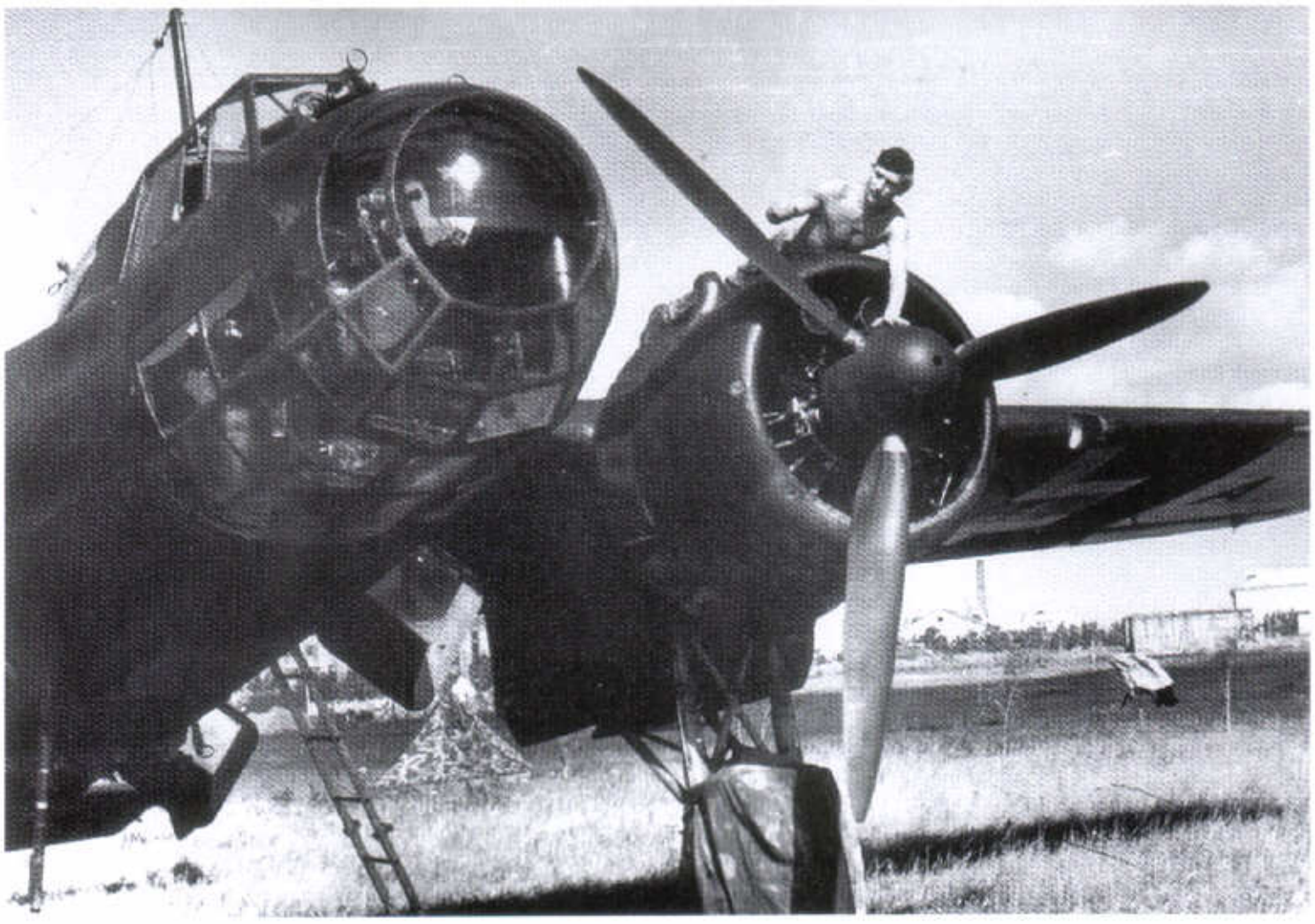
For the upper side aviation lacquer 7122.72 or 73;
For the underside Fl. Lacquer 7122 (any shade),
Aviation lacquer 7123 and 7122.22.

The white angles of the cross and swastika will be applied, using aviation lacquer 7164.21.
Individual parts of the surface of the aircraft are stopped, e.g. impact dents and dents resulting from riveting. DoN 1318 applies to the control surfaces.

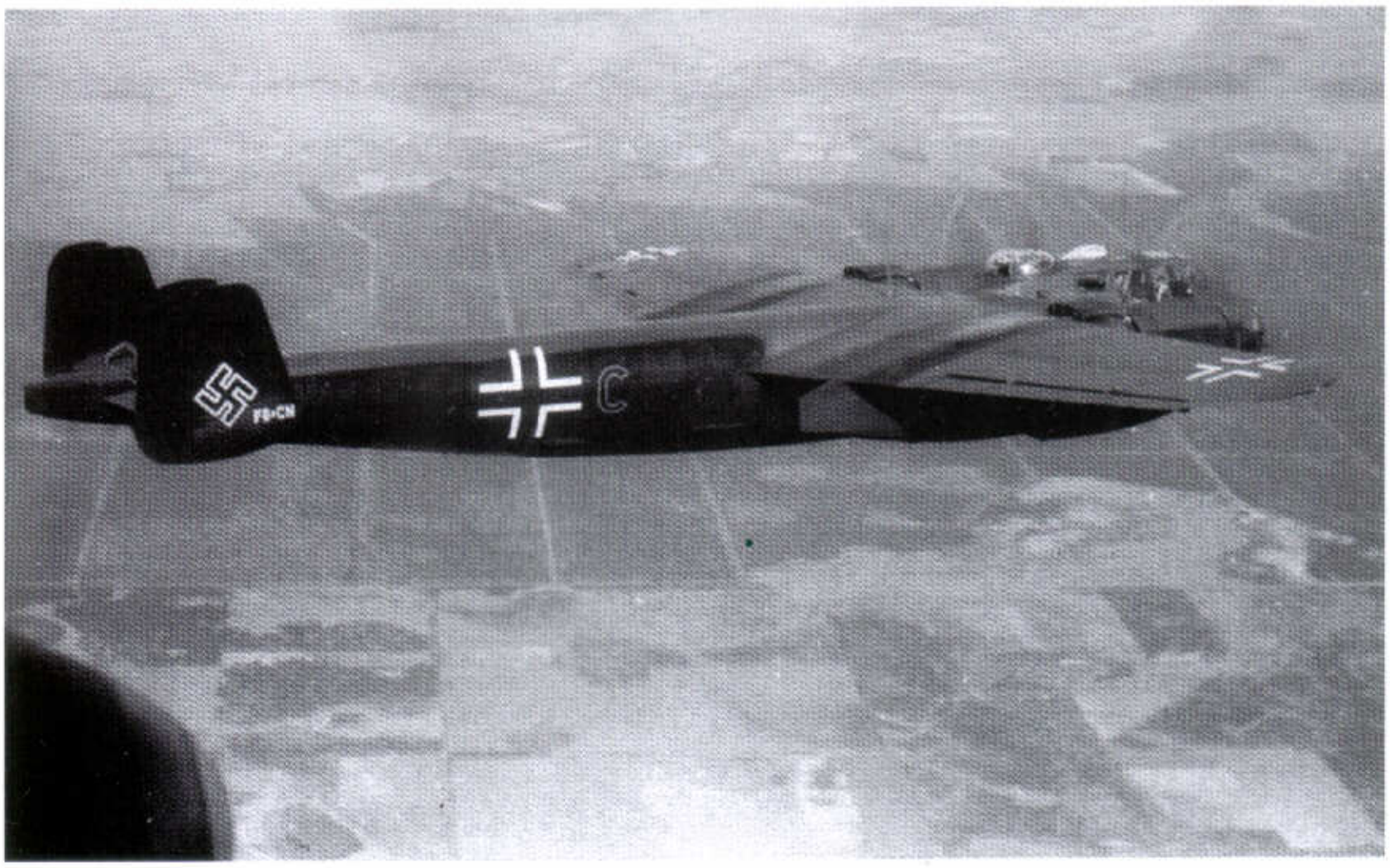


217: *This extract from the official handbook shows the camouflage pattern for the Dornier Do 217M*

218: *This He 111 of KG 26 has also been finished in temporary black night camouflage on the underside. However, despite the fact that the 1800 kg SC 1800 bomb (known as 'Satan') sitting in front of the bomber was too big to be carried internally and had to be slung from underwing racks, it remains in 65 Hellblau. The individual aircraft letter, 'D', has been applied to the wing leading edges to assist crews to find their aircraft in the dark prior to takeoff*



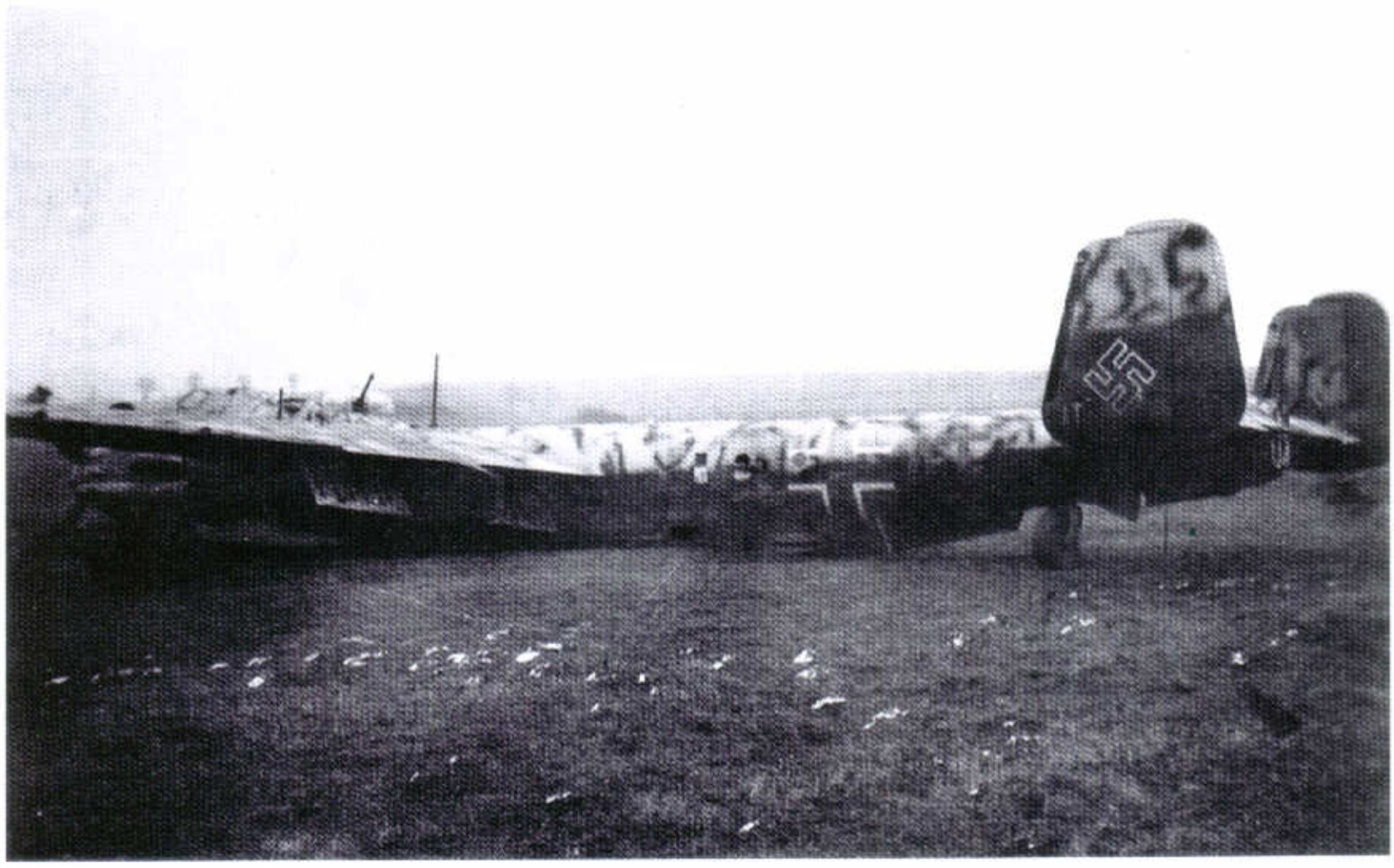
219: *This Dornier Do 17P of an unidentified reconnaissance unit appears to be finished in washable night camouflage which has started to wear off from the engine cowling. 'A' may be serving on the Russian Front as the wingtips seem to have, oddly, been left in yellow, which seems to defeat the purpose of the night camouflage*



220: *A Dornier 217E-2, F8+CN, of 5./KG 40, photographed over France in 1942. The uppersurface camouflage pattern appears to have faded to an overall dull green but the black to the underside seems fresh. It has been applied in accordance with instructions, while the Balkenkreuz has had the paint from the white angles washed off or re-applied for daylight flight, also as per instructions. The code letters can just be made out against the camouflage on account of their slightly shinier finish and the red 'C' is outlined in white. Very unusually, the propeller blades appear to have yellow tips*

221: *Another view of* Lt *Dolenga's Dornier Do 217E-1, WNr 0069, U5+DN, of 5./KG 2, (see photo 103) in the low contrast 72/73 camouflage. The aircraft had received a removable night camouflage on the undersurfaces which also obscured the fuselage markings. The Balkenkreuz was not repainted with the special marking colour 77 and the swastika had remained untouched. The fin sports two ship kill markings*

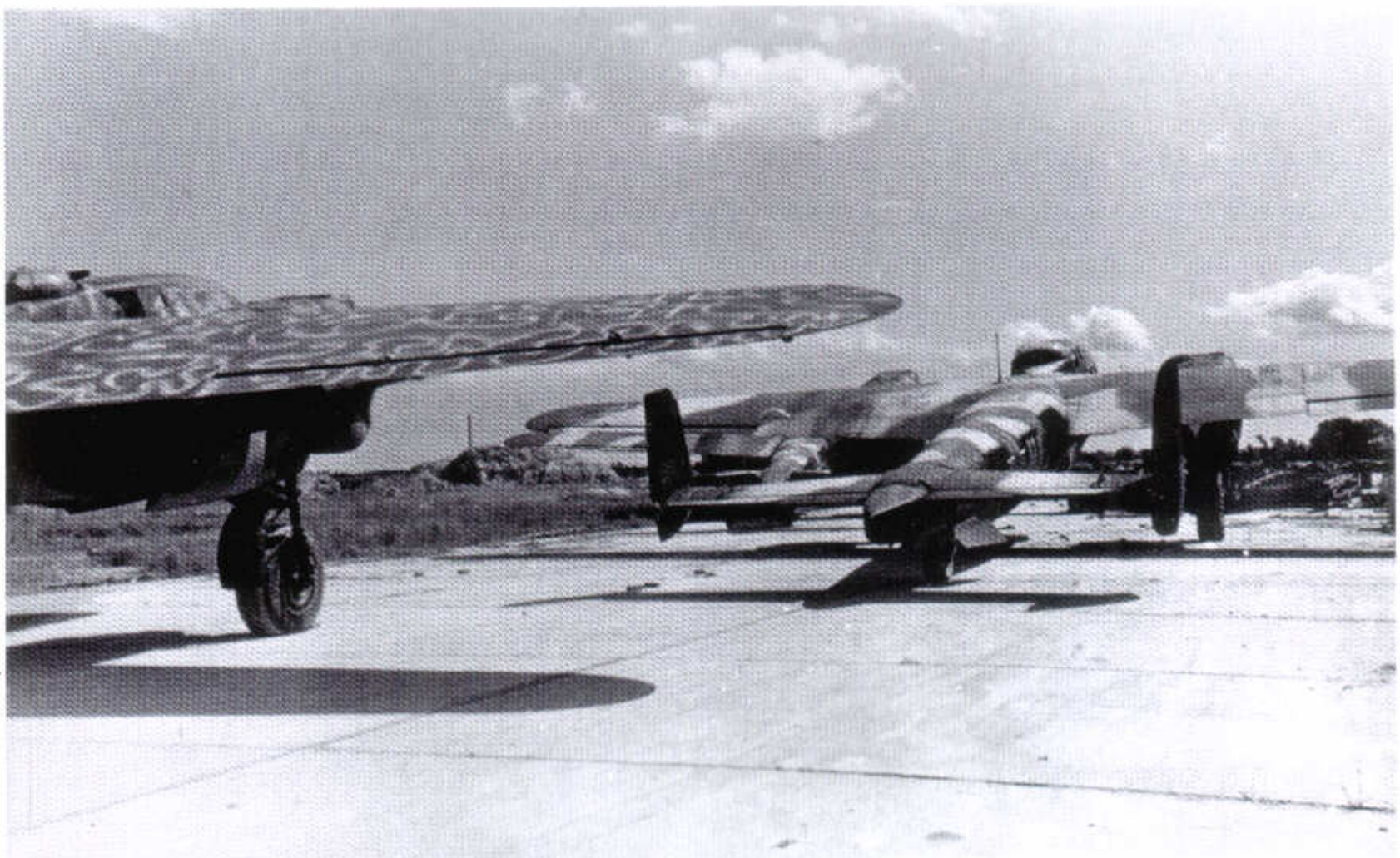
222: *A Dornier 217M (WNr 13?) in standard camouflage for the type. An interesting feature on this photo is the matt appearance of the unreadable radio call sign on the fuselage, the light colour on which resulted from dirt on landing on a muddy airfield. Clearly visible are the flame dampers over the exhaust pipes which have been burned down to the bare metal by the heat. Note the fuselage Balkenkreuz is of the maximum simplified type with just the narrow white portions*



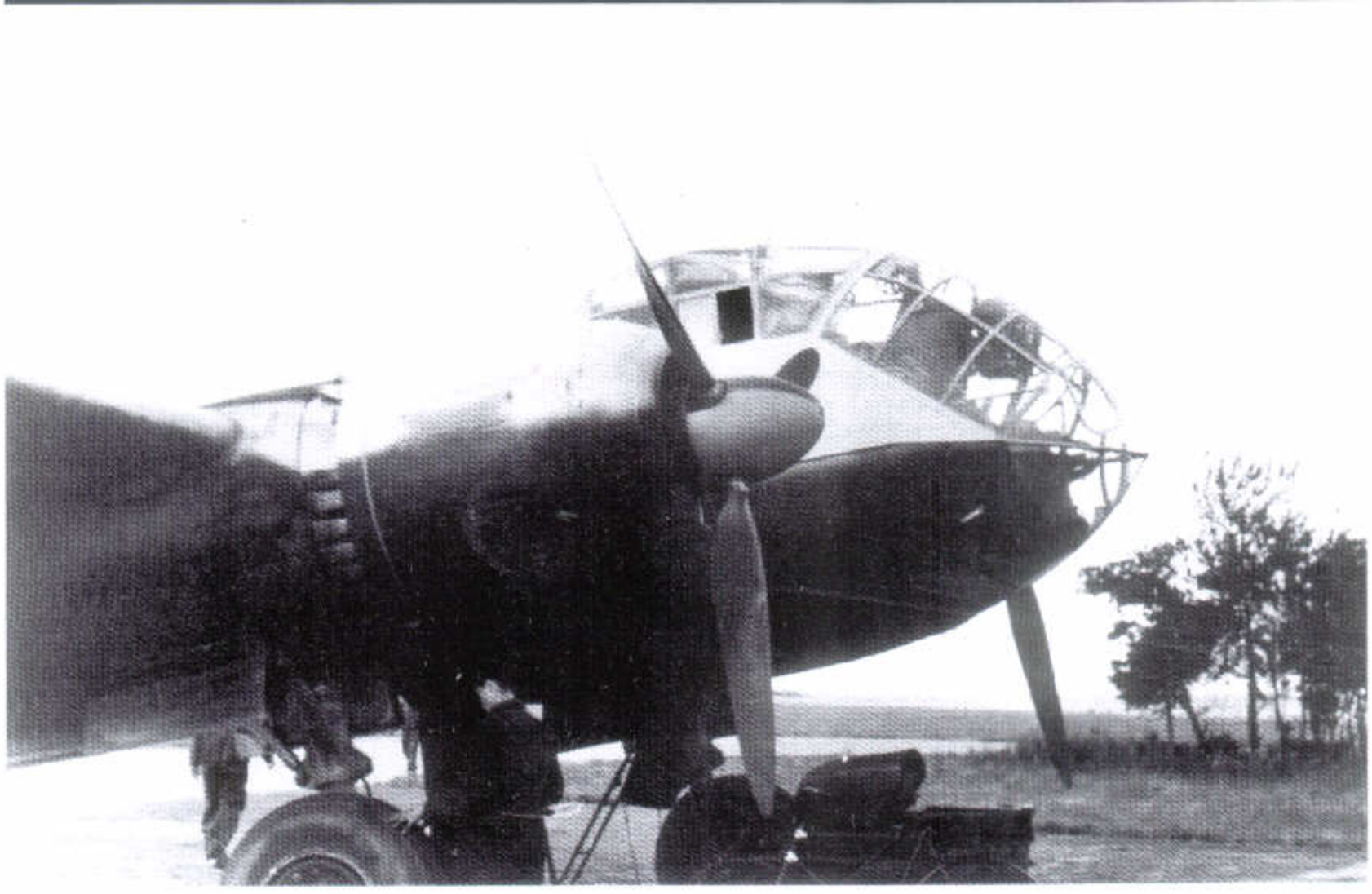
223: *A Dornier Do 217M which crashed near Toul in France in late 1943-early 1944. The aircraft wears the last two letters of a just discernible code, 'AT' in 77 or, more likely, 23 Rot. Barely visible on the fin is a yellow werk nummer, 3046(?). Undersides are entirely 22 while the upper surface and upper halves of the rudders are 76 with a meandering black line sprayed over the top. National insignia are just the white portions. The camouflage style suggests that this could be a machine of KG 2 during their involvement in 'Operation Steinbock', the 'Little Blitz' against Britain*

224: *This view of the same Do 217M in the previous picture shows the propellers to be entirely finished in 70 Schwarzgrün*

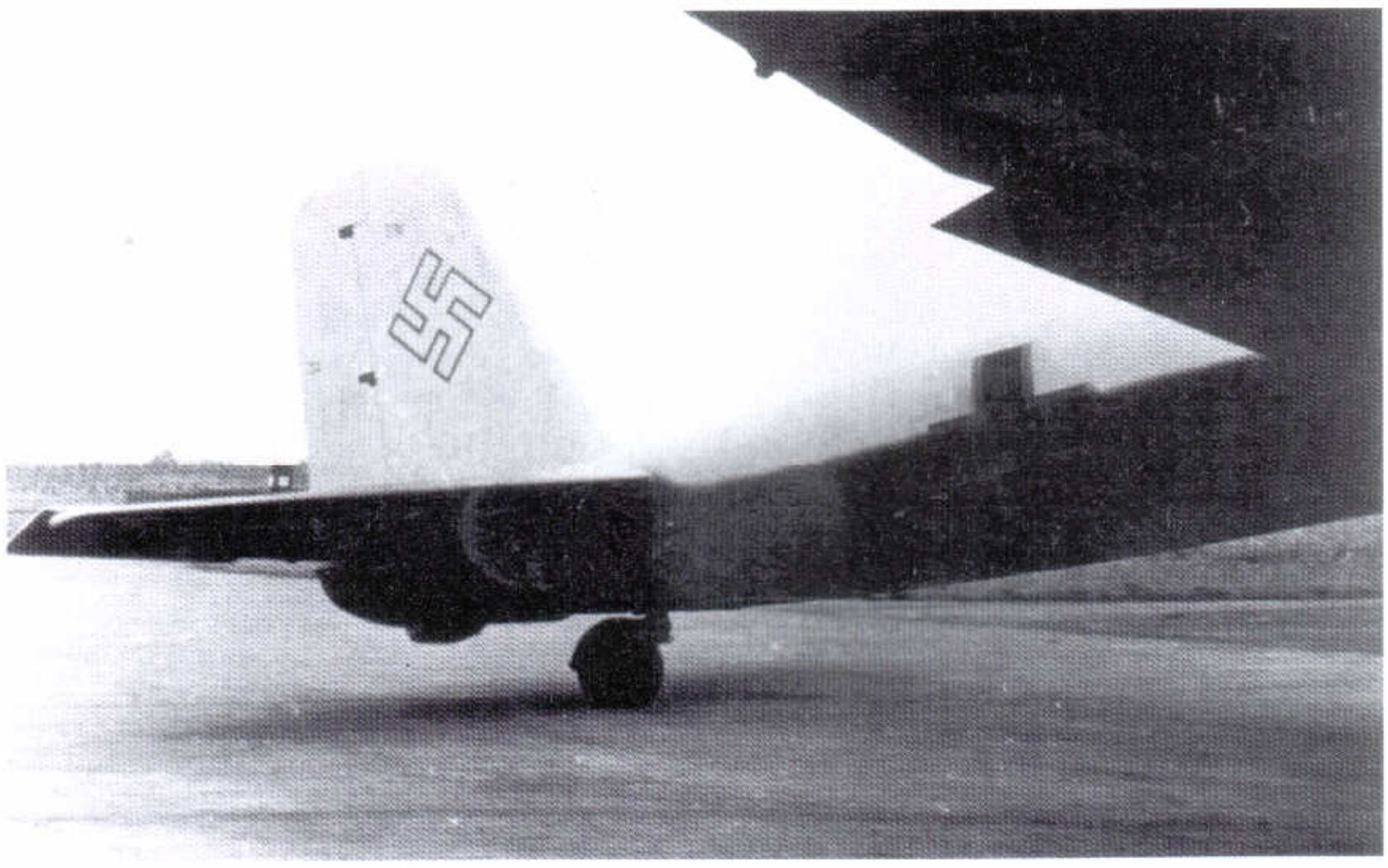
225: *Seven Dornier Do 217s were found at Beldringe in Denmark in May 1945. Nearest is Do 217N-1, 'MN', WNr 158 (?), which wears a scribble of 65 or 76 over the basic 72/73 uppersurfaces. Undersurfaces were 65. Further back another two aircraft, the nearer coded 'HK', are finished in 22 below with a coat of 76 on the upper surfaces which has had large segments of 74 and 75 added. All visible insignia are of the maximum simplified style in white against the dark backgrounds in accordance with official instructions*



226: *This abandoned Ju 188A, 3E+HK, of 2./KG 6, found at Melsbroek in Belgium was clearly finished in RLM 76 on the upper surfaces which has had broad stripes of black applied over the top. It seems that a new port wing, minus flaps, was fitted after battle damage. The fuselage cross is white, not 77 as it should be on night camouflage, while the 'HK' is yellow with a black border. No wing cross or swastika is visible, against regulations. Also visible is the fuselage of a wrecked Bf 109G, painted in two very dark tones (70/82?, 82/83?) with no light coloured underside visible*



227: *Pictured at Montdidier in France in 1944, this is* Lt *Hans Altrogge's Ju 188E-1. Part of the pathfinder unit I./KG 66, it is finished in 76 on the uppersurfaces, 22 below. Half the spinner was finished in standard 70, the rest in a lighter tone, possibly red, the staffel colour. The aircraft was modified for extra speed by the removal of the dorsal turret and a balloon-cable cutter was fitted around the nose*



228: *The tail of Altrogge's aircraft reveals part of a unit code, 'TN', in small black figures high on the fin. The complete code would have been 'Z6+TN', which indicated aircraft 'T' of 5 Staffel. I./KG 66 was unusual in that it had five staffeln but only one Gruppe, the 5 Staffel of which existed only from May-September 1944. The swastika here is correctly in black only but the Balkenkreuz appears to be in a non-standard very dark grey, probably in an attempt to resolve the extreme difference in tone between upper and lower surfaces*

229: *A Bf 109D, N+1, of 11(N)./JG 2 pictured at Vaernes in Norway sometime between May and late August, 1940. At this time 'twilight' fighter units were just being formed as additional staffeln to fighter gruppen. These aircraft were identified by the letter 'N'—'night'. This is probably the Staffelkapitän's machine, finished in 71/02/65. Balkenkreuz and swastika are of the 'early war' style with thin black borders, the number and letter are red*

Sammelmitteilung 2 (Collective Announcement 2) of 15 August 1944 describes this permanent night camouflage and how it should be processed in fine detail. This text is remarkably similar to that in L.Dv 521/1 of 1941, to which the text set out below could be physically added as an insert. In actual fact, the change to L.Dv 521/1 was not made with this Collective Announcement. It was left in mid-air, as it were, as an unrecorded amendment:

"Introduction of night camouflage Flw 7126.22
A.82b 30.
The past night camouflage Flw.7123.99 and Flw.7124.22 (permanent night camouflage) under L.Dv 521/1 pp. 20/21 and p. 42 is replaced by night camouflage Flw.7126.22.

Purpose and scope.
Flw. 7126.22 is a single paint permanent night camouflage applied on top of the existing coat (e.g. Flw. 7121) to the extent indicated in the camouflage drawing.

Application
Flw. 7126.22 is supplied in concentrated form and must be thinned with aviation thinner 7205.00 in a ratio of 2:1 so that it possesses a viscosity of approx. 13.5 sec. in the 4 mm ø – DIN beaker. It is sprayed at 3 atms with a 2-3 mm diameter jet smoothly over the existing paint without misting. On mass production, Flw. 7126.22 can already be sprayed 30 minutes to one hour after applying Flw. 7121. It is dust dry after 40 min. and dry enough for transportation after 2 hours. On older aircraft, the existing paint must be cleaned before applying the night camouflage with the prescribed alkaline cleaning agents (organic cleaning agents must not be used), washed down with water and dried.

Please note! Stir the paint well without fail so that all pigments producing the camouflage effect are uniformly distributed.

Marking
Section V on page 18 of L.Dv 521/1 continues to apply to the markings on aircraft for night operations.

Supplier
Dr Fritz Werner, Berlin – Oberschönweide, Fuststr. 1-25, Tel. 633232.
Existing stocks of Flw. 7124.22 will be used up wherever possible.

Introduction of camouflage paint Flw. 7126.76 replacing Flw. 7125.65 (cf. L.Dv 521/1 Section G.S. 41/43).

Flw. 7125.65 is replaced by re-camouflage colour Flw. 7126.76.

Purpose and scope
The blue re-camouflage is used to change aircraft from the permanent night camouflage to daytime camouflage.

Application
The aircraft is cleaned down with the prescribed alkaline cleaning agents (organic cleaning agents may not be used). The Flw. 7126.76 supplied ready for use is applied after drying in the direction of flight fully over the existing camouflage paint to the required extent. The national markings are left uncovered. Masking off with masking tape or the like is unnecessary as the paint is applied with a brush. The coat is dust-dry after 40 minutes and ready for transportation after two hours.

Supplier:
Dr. Fritz Werner, Berlin – Oberschönweider, Fuststr. 1-25 Tel. 633282.

NB: Flw. 7126.76 is largely used in the field."

Compare the above text with the corresponding passages in L.Dv 521/1 of 1941. Numerous parallels will be recognised.

The last of the bombers to come off the assembly line were supplied with a permanent night camouflage, as the drawing of a Dornier Do 217M opposite shows. Aviation material No. 7122 of the lacquer used corresponds to the standard lacquer for interiors and to the exterior lacquer for single paint processes.

Night fighters

At the start of World War II, the camouflage for night fighters was the same as that for daytime use:

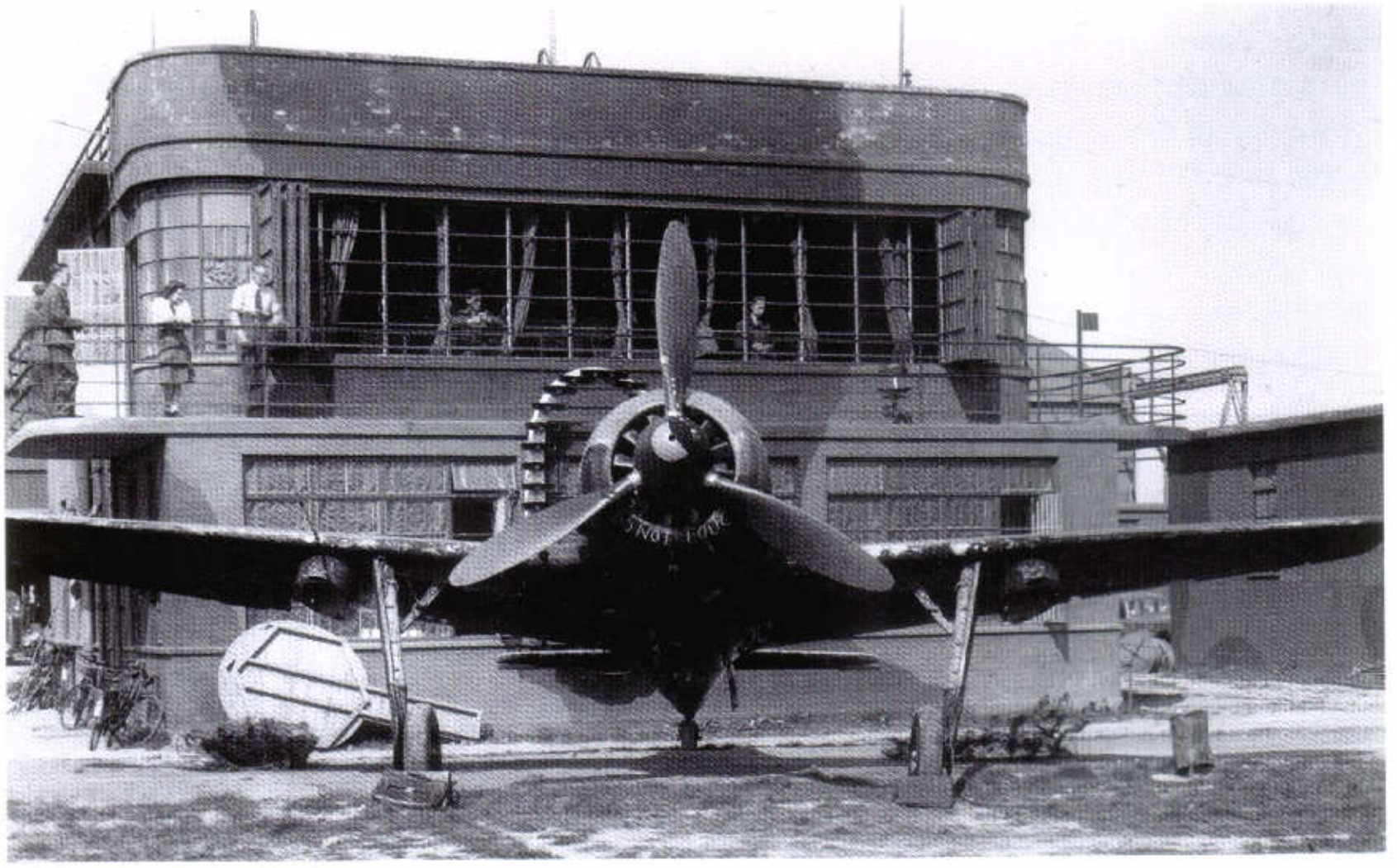
RLM 70	Schwarzgrün	Black-green
RLM 71	Dunkelgrün	Dark green
RLM 65	Hellblau	Light blue

Unlike daytime fighters, night fighters carried an 'N' (indicating 'nacht' — night) to the left of the *Balkenkreuz*.

The upper sides of aircraft used as night fighters were painted with RLM 22 Schwarz from 1941. The underside retained its coating of RLM 65 Hellblau.

Where necessary, the underside was provided with a removable night camouflage (as previously explained) in accordance with L.Dv 521/1. This paint was replaced by RLM 22 only a few months later, in spring 1941. The marking 'N' was replaced at the same time by the standard Luftwaffe call numbers in RLM 77.

The following text passage concerning the Do 217J has been taken from the LDv (of August 1942) and confirms its overall finish in RLM 22:



230: Fw *Otto Bechthold landed this Fw 190A-4/U8, WNr 47155, 'Yellow H+▲', of II./SKG 10, in error at West Malling on 17 April 1943. This view (taken outside the control tower at West Malling) clearly shows the sooty appearance of the temporary 7120.22 black night camouflage. As directed, it has been applied only to the undersides, the remainder of the aicraft retained its 74/75 finish. Note the yellow 04 spinner tip partially overpainted with 22. The aircraft was lost on 13 October when it crashed while under test with the RAF, the pilot being killed*

231: Oblt *Kamp, staffelkapitän of 7./NJG 4 and his Bf 110E-4, 3C+AR, during a transit flight in 1942. Finished is the permanent 7124.22 black paint. According to regulations the code letters should be 77 but appear too dark. The cross should also be 77 (see page 225-226) but it is obvious that it is white, while the letters could be a dark grey or possibly red*

232 Below: *A Bf 110C-2 of Stab I./LG 1, L1+XB, (green 'X'), finished in standard 70/71/65. Many early Luftwaffe night fighters bore this scheme. Note the glossier finish to the wing cross in the foreground*

"3. Finishing and Lettering
a. Camouflage Paint

The aircraft are finished in night-camouflage overall, i.e. all exterior surfaces except windows and markings are painted black.

The bare metal or anodised surface or the paint already present is oversprayed with:

One coat aircraft paint, shade 72 (or any other available shade of the same paint),
One coat aircraft paint 7123
One coat aircraft paint 7124, shade 22."

The new edition of L.Dv 521/1 when it appeared in November 1941 failed to mention night fighters. RLM 22 Schwarz therefore remained standard throughout.

The first night fighters in colour RLM 76 Lichtblau appeared at the end of 1942. Apart from the addition of patches of RLM 75 Mittelgrau, this remained the standard colour for night fighters right to the end of the war.

There were numerous variations of this scheme, e.g. with the whole of the underside or of just one wing (usually the starboard) painted in RLM 22. This is believed to have been a form of tactical marking used briefly by some aircraft at the beginning of 1944. From the end of 1944, the colours:

RLM 81	Braunviolett	Brown violet
RLM 82	Dunkelgrün	Dark green
RLM 83	Hellgrün	Light green

were also used for camouflaging the upper surface of night fighters. The paints were applied individually or together on the RLM 76 upper surfaces in patches, whole areas or wavy patterns.

233 Below: *The drawing below illustrates the factory camouflage pattern for the Dornier Do 217N and dates from February 1943*

3. Paint and Markings

a. Paint and camouflage

217N-1 aircraft are to be camouflaged according to drawing 217 N-1 p. 10 (Fig. 12 below). The aircraft and its parts are painted in accordance with DoV 1728.

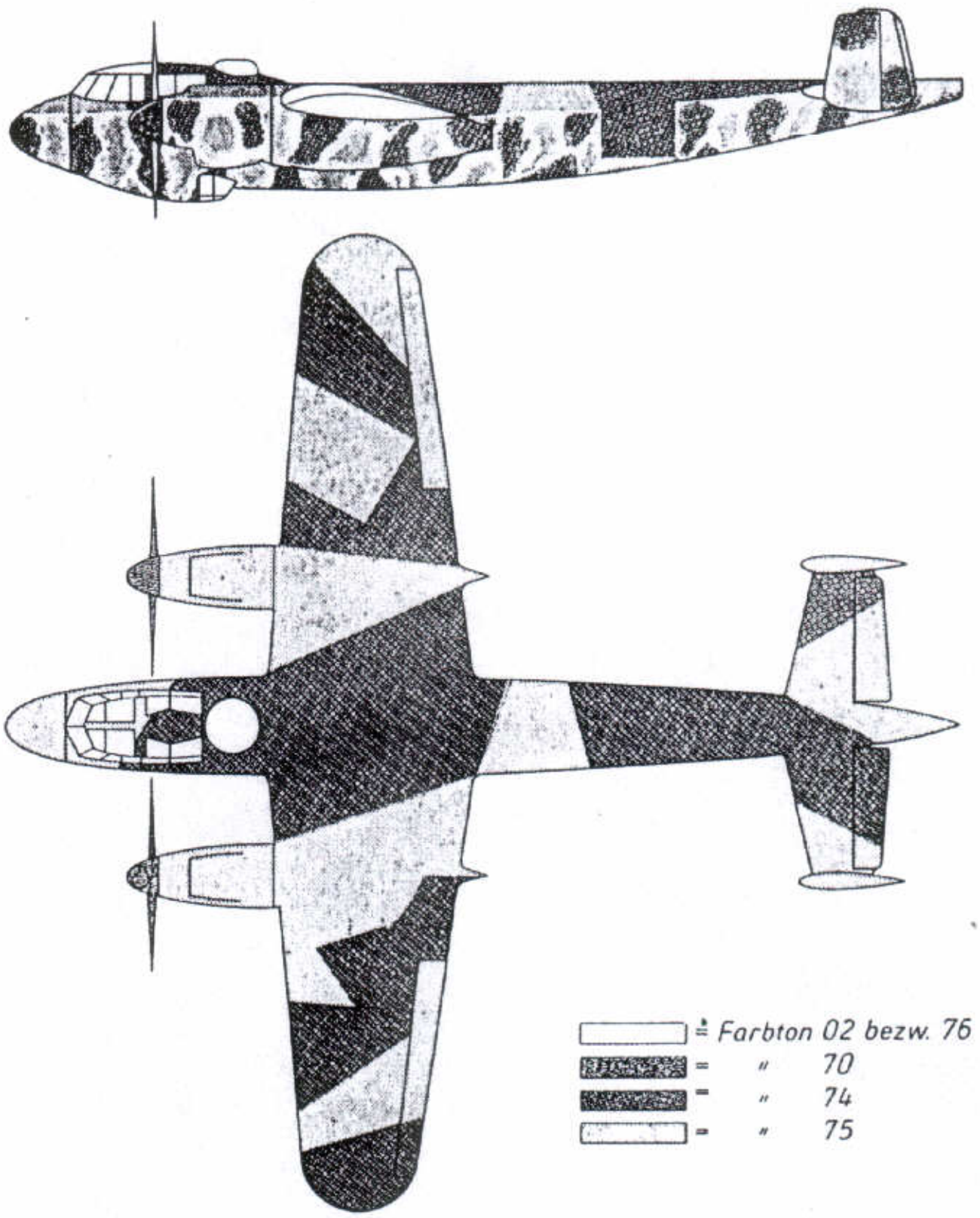
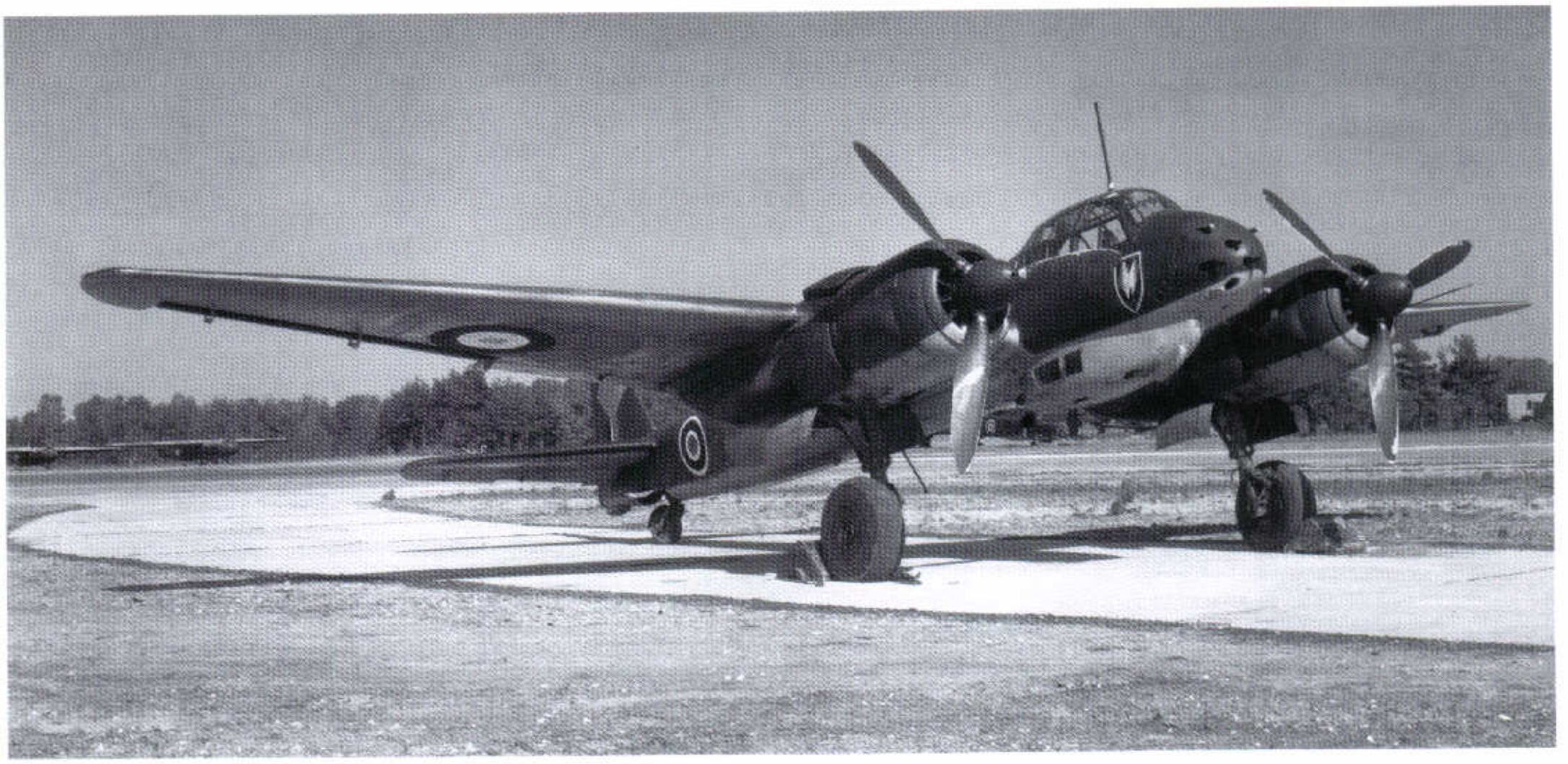
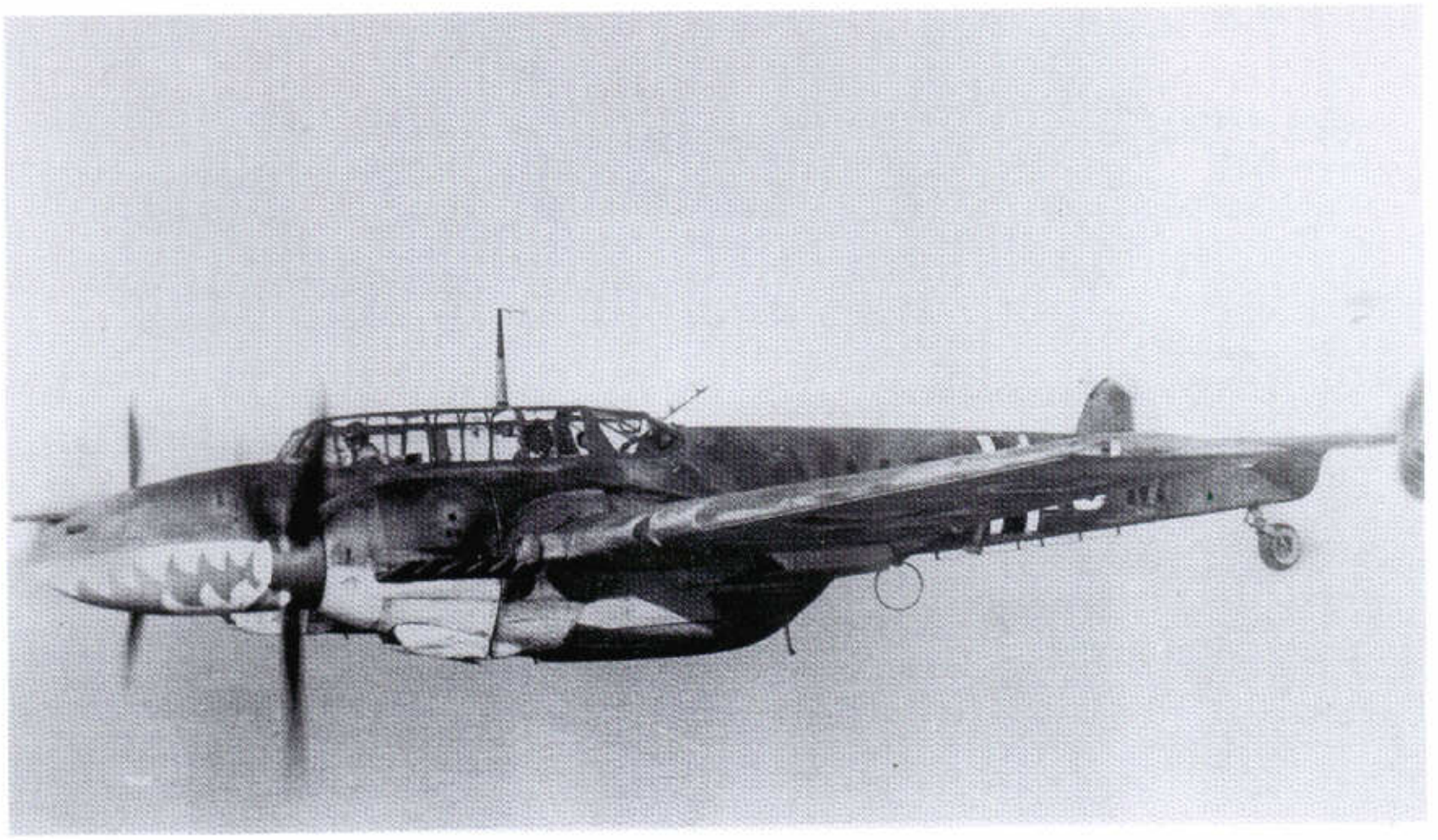


Fig. 12 Camouflage



234 Above: *Ju 88R-1, WNr 360043, D5+EV, in British markings. The aircraft has a 70/71/65 finish with over-painted German markings. The sharp colour demarcations line between the 65 and the upper camouflage colors is a sign of careful application of the paint, giving the expensive aircraft very good surface protection*

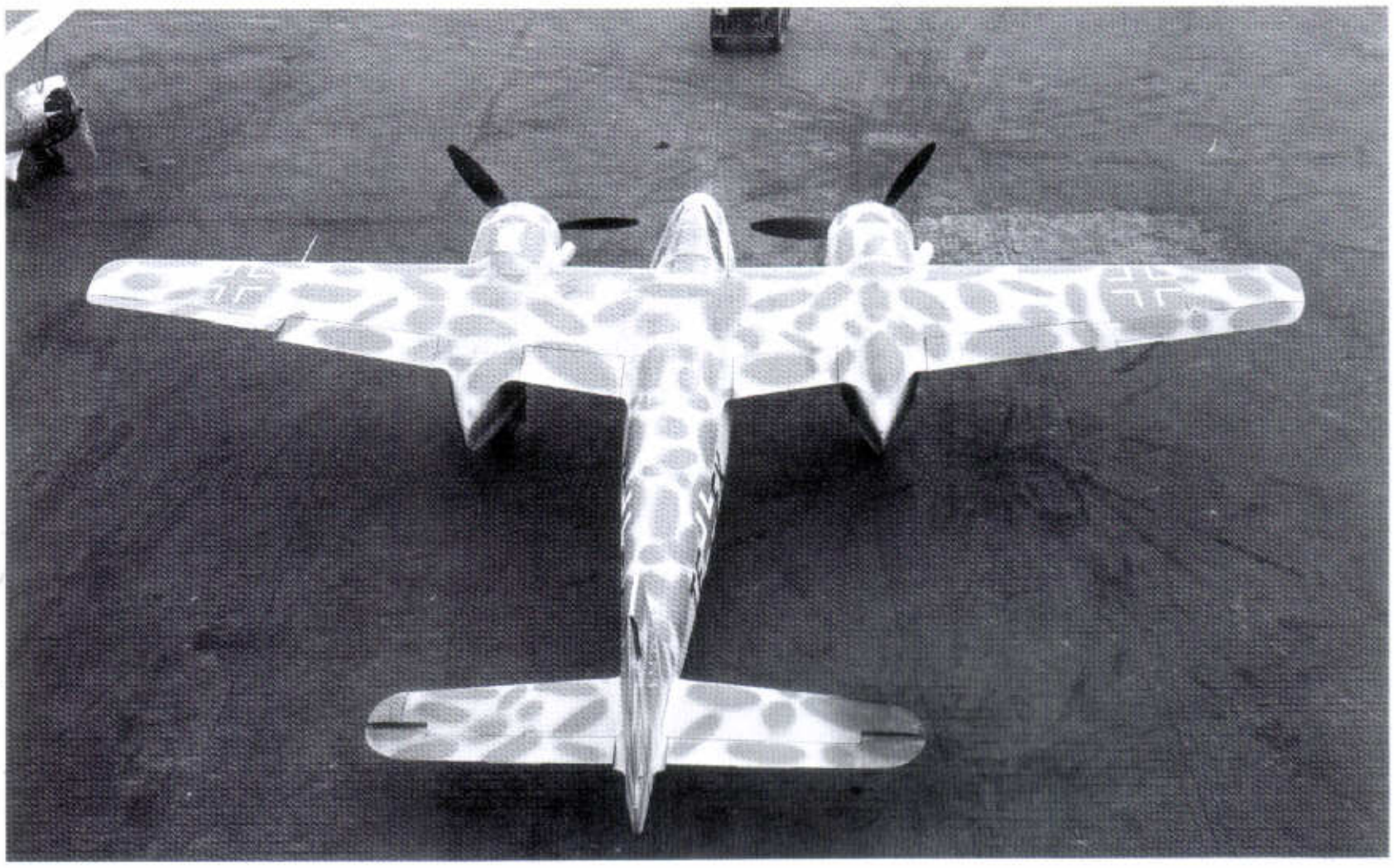
235 Left: *A shark-mouthed Bf 110E of NJG 3, apparently in 74/75/76 with a zig-zag line of 76 over the uppersurface camouflage. Whether this was intended as snow or night camouflage is not clear but would probably function as both*



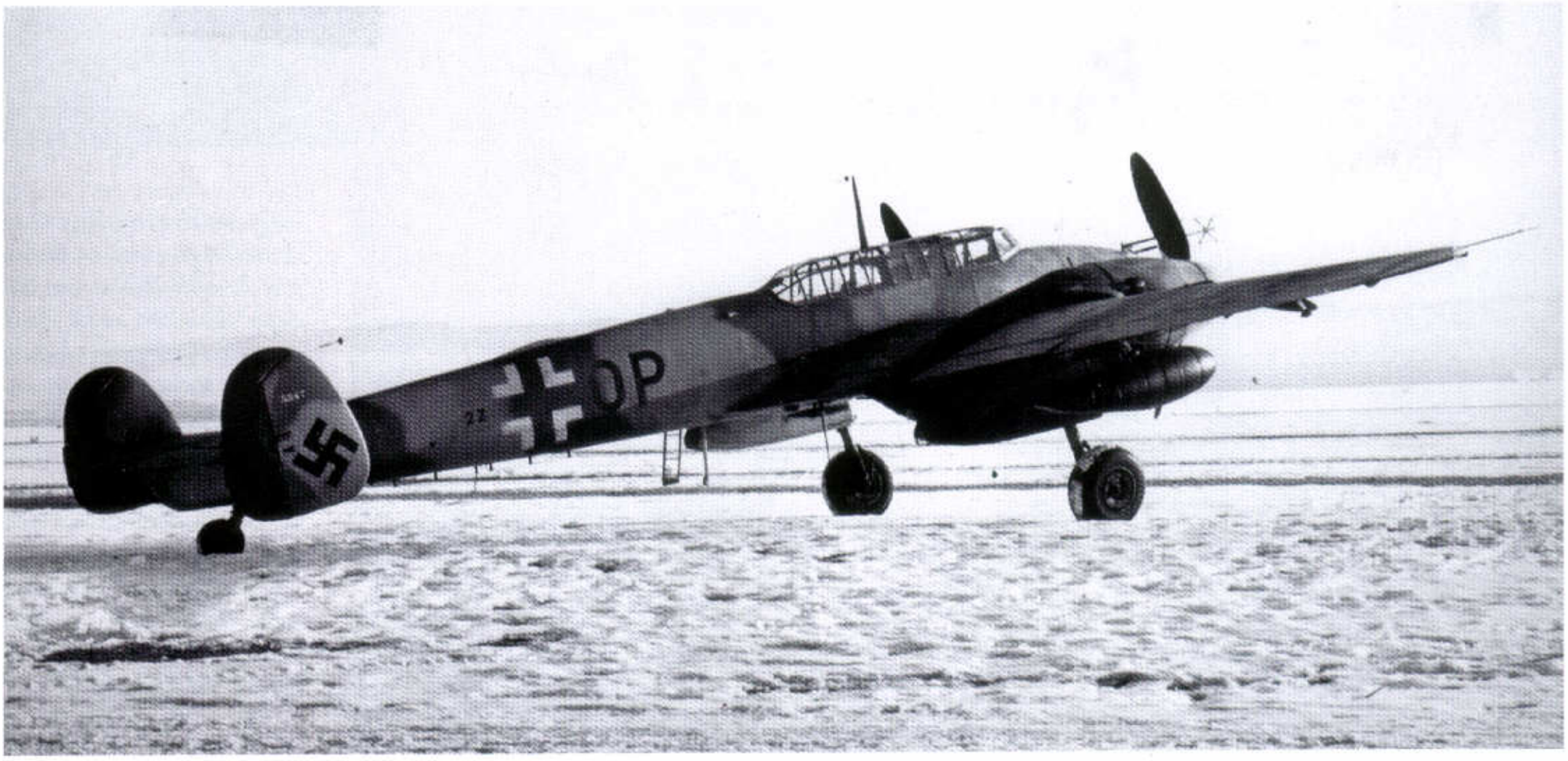
236: *Bf 110F, M8+CM, of 4./ZG 76 wears a very similar 74/75/76 camouflage and sharkmouth to the aircraft above, although not a night-fighter. The individual aircraft letter 'C' and the spinner tips are in the staffel colour of white. Rudders and the lower portion of the engine cowlings appear to be yellow*

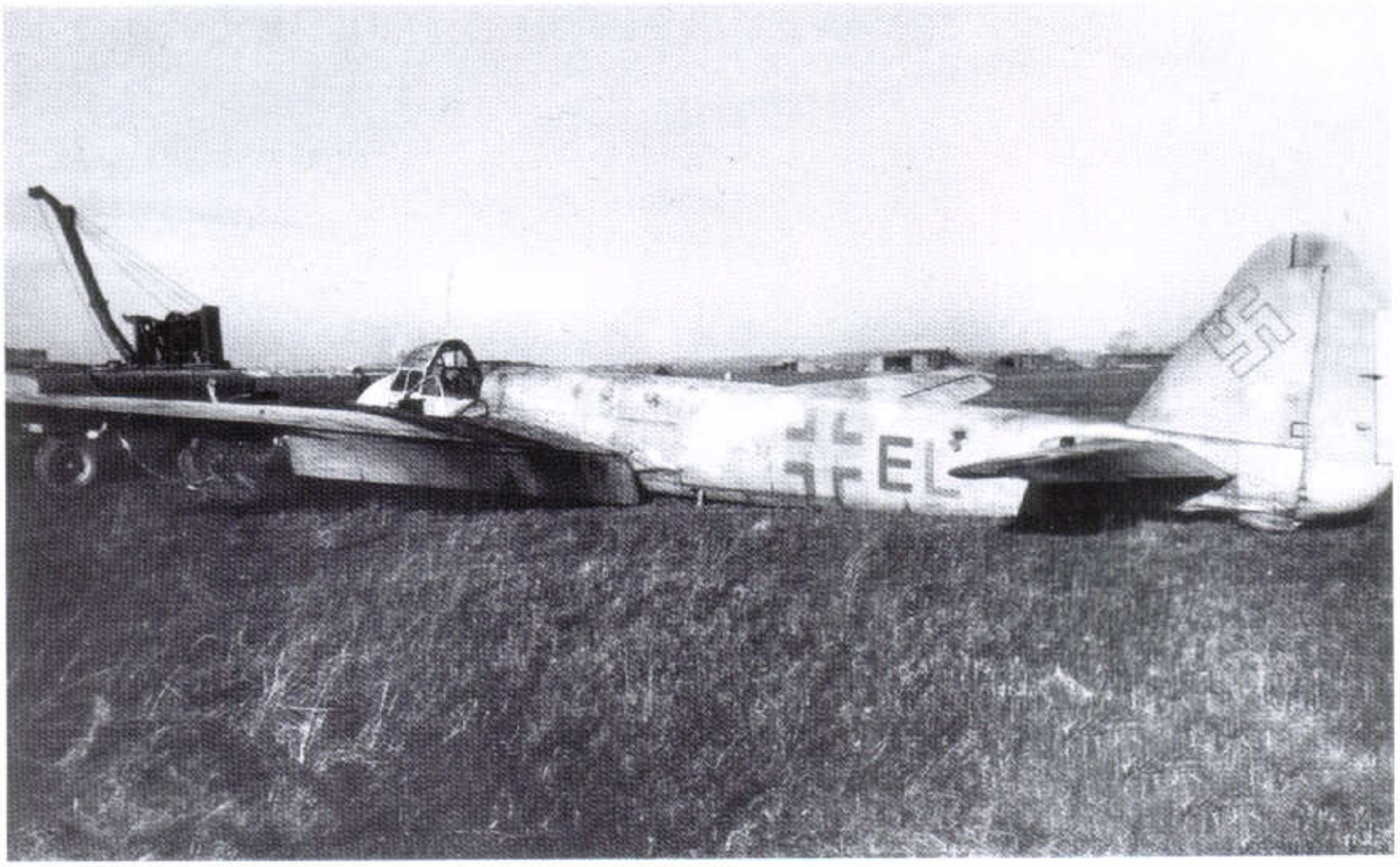
237: *This is the brand new Focke-Wulf Ta 154V-7, finished in accordance with the camouflage instructions for nightfighters: an overall coat of 76 with 75 blotches. In the case of the all-wood Ta 154 these paints would be from Lacquer Group 30 (see page 223). In accordance with regulations the national insignia use the white portions only against the dark 75 (see page 155) while the letters are in black. Spinners and propeller blades are in 70. The undercarriage members are clearly 02*

238 Right: *An overhead view of the Ta 154V-7 showing the 74 blotches on the 76 base. The simplified wing Balkenkreuz are correctly in white on the dark background*



239 Below: Ofw *Treynogga flew this Bf 110G-4/R1 night fighter, WNr 5547, in a very unusual camouflage of 74 with large segments of 75 over a half black 22 and 76 undersides. 2Z+OP of 6./NJG 6 wears an interesting interpretation of the official orders: the white Balkenkreuz is correct against the dark camouflage color and, also correctly, the black swastika is on a large field of 76. Spinners were 76 with a white ring, overspray from which had covered the blade roots. Dubendorf, Switzerland, 15 March 1944*



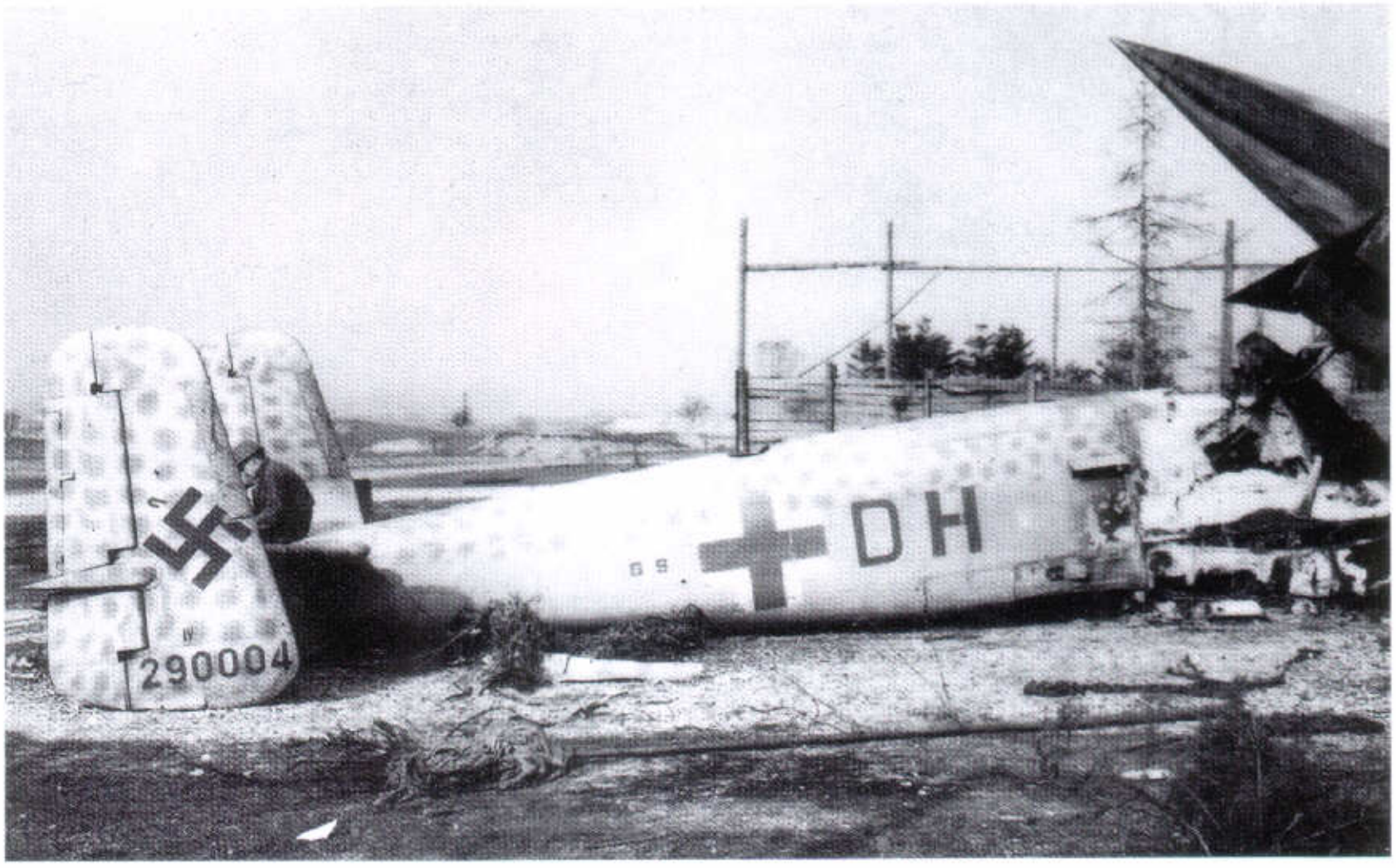


240: *This Ju 88C of 2./NJG 4, 3C+EL, was written off in France in November 1943. It was in overall 76 with light blotches of 75. Fuselage Balkenkreuz, swastika and codes were completely simplified in black in accordance with regulations but appear to have been lightly oversprayed. 'E' remained in black*

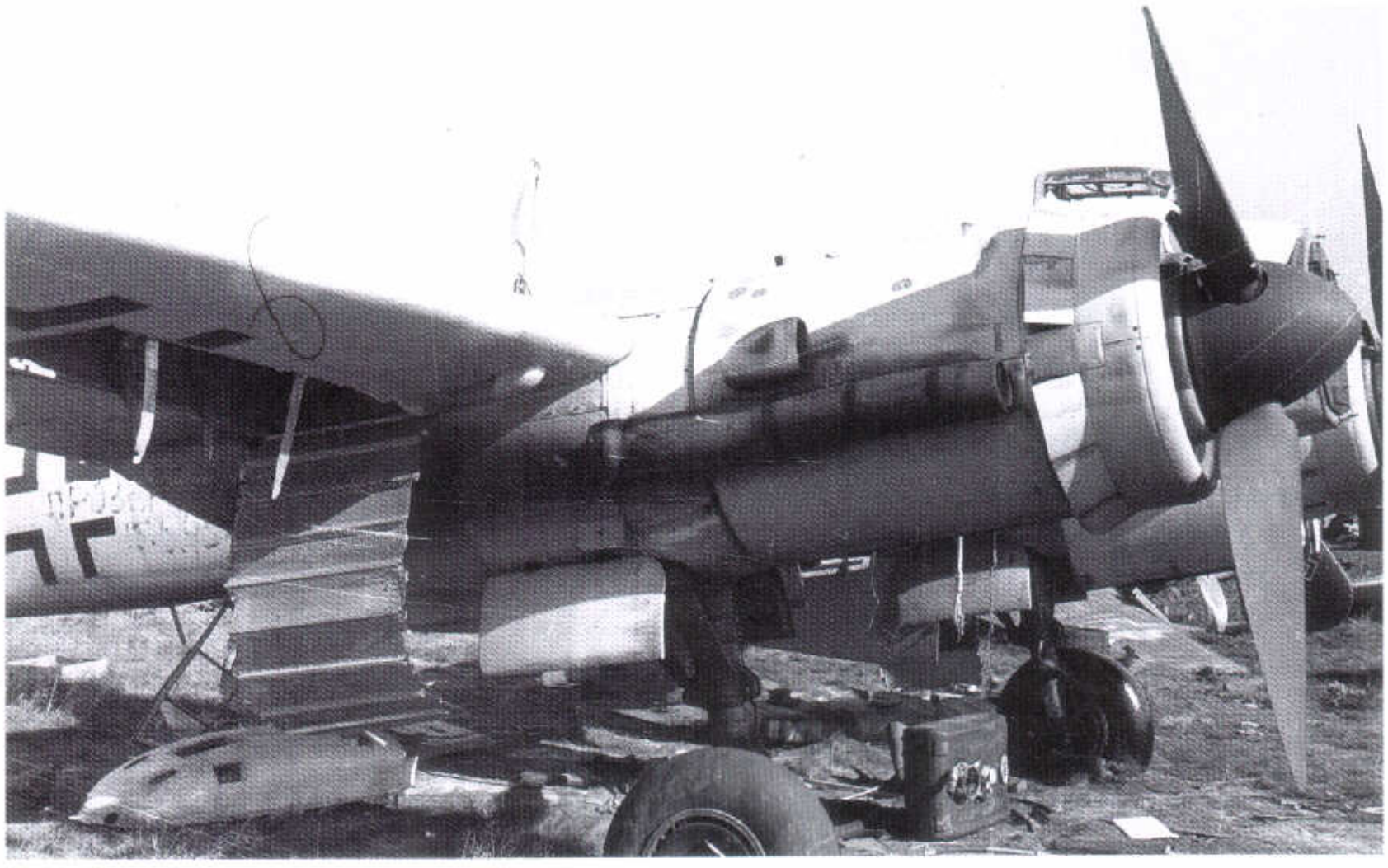
241 Below: *Dozens of camouflage variations: Ju 88 bombers in green; Ju 88 nightfighters in overall 76 finish with 'wave' lines of 75 or 81 or other dark colours and Bf 110 nightfighters in another kind of 76 finish with solid RLM 75 on the topsides*

242: *An Heinkel He 219 of an unknown unit in standard 76 with 75 blotches but non-regulation solid black crosses, apparently without any white angles. These may be the remnants of factory-applied markings, painted in accordance with the drawing shown on page 156*

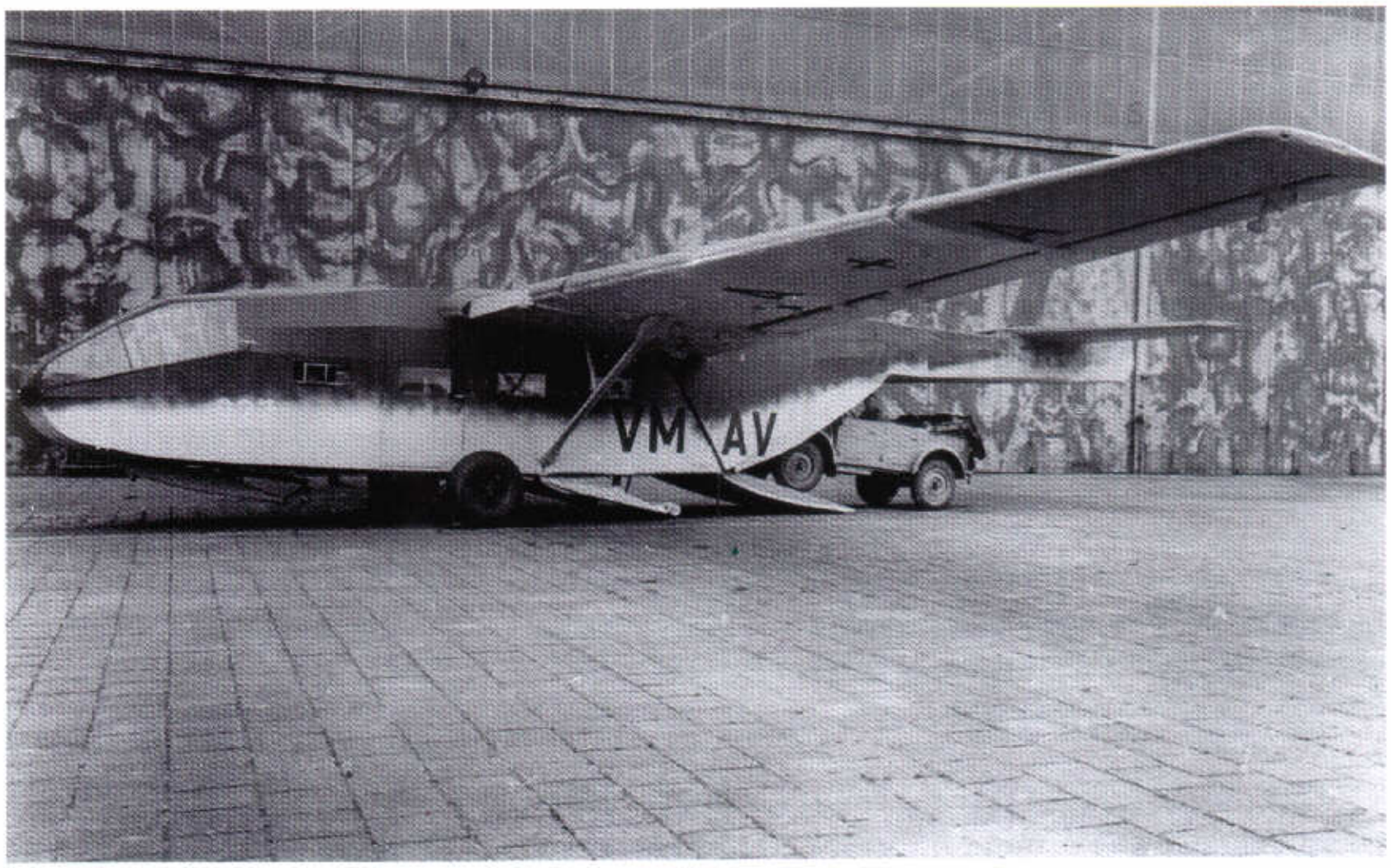
243: *An Heinkel He 219, WNr 290004, G9+DH, of 1./NJG 1, finished in overall 76 with blotches of 75. The blotches of 75 are so symmetrical that it is possible that they were sprayed with a mask or template. The werk nummer is displayed large in black as a transit marking, as required by regulations introduced in July 1944 (see page 173). Swastika and Balkenkreuz are both in the simplified form. Inside of the fuselage Balkenkreuz is filled with RLM 75, as required from 1944 (see page 155)*



244: *A wrecked Ju 88C-6 in overall 76 with very sparse blotches of 75. The 76 is of the very pale shade common at the end of the war. Propellers are 70 and all visible insignia are of the maximum simplified type in 22. Berlin-Gatow, September 1945*



245: *This Gotha Go 242 was modified to try out the rear-loading ramp and door for the proposed Gotha-Kalkert Ka 430 transport glider. The overall dark tone of the uppersurfaces suggest that the aircraft is finished in the new shades 81 and/or 82. (See page 121). The very pale undersides suggest the use of 76. Apart from the aircraft code letters, 'VM+AV', and underwing Balkenkreuz, the machine is unmarked, although it does have yellow wingtips on the undersurface. Note the camouflage on the building behind which could well be in similar shades to the aircraft*



GLIDERS AND SAILPLANES

New colours for new problems

As with every airframe for which the RLM was responsible, the prime requirement was to protect the materials used against environmental influences to ensure the longest possible working life and, consequently, maintained operation. This attitude may now well be difficult to comprehend in our consumer (disposable) society, when materials maintenance and care may be more expensive, because of the labour element, than discarding the used and worn-out item and purchasing a new one.

L.Dv 521/2 of 1943 lays down the following colour scheme:

> "Gliders are predominantly made of wood and fabric. As a protection against the influences of the weather, all structural parts inside and out must be carefully painted. According to this definition,
> Gliders are painted neutral
> Sailplanes are painted in colour.
> The work required is described below according to the materials used and according to the interior and exterior painting schemes."

Coloured means painting in shade 05 Elfenbein (Ivory). Further details appear in the full reprint of L.Dv 521/2 on page 240 of this book.

In the early years of the war, gliders and sailplanes were painted in accordance with L.Dv 521/2. As the war continued, however, air space above Germany became ever less safe as it was penetrated by Allied aircraft. The Allies were in no doubt that gliders were used for training pilots of the future. This is also evident from L.Dv 521/2:

> "The importance of gliding as pre-military training and for securing the new intake of pilots was a reason for RLM undertaking the development and procurement of the necessary training equipment. This equipment could be produced and maintained only by simplifying the materials and working procedures used. The RLM decided and licensed the painting systems for gliders for this purpose. The necessary materials were obtained from a number of firms under the same descriptions."

Inhibiting this training therefore became an Allied war aim. Known training centres became targets for bombardment. Fighter escorts had the secondary task of attacking everything that moved after the primary operation had been completed, favourite targets included the gliders. Defenceless in the air, these were an easy target on the ground, necessarily standing on clear, level sur-

246 Above: *Found at Catania in Sicily, this Gotha Go 242 is probably finished in 70/71/65. The remains of the number '3' can be just made out behind the wing strut. Yellow wingtips suggest that the aircraft had been sent direct from the Russian Front. Underwing Balkenkreuz are definitely non-standard*

faces. This led to instructions being given to camouflage gliders to make them more difficult for the enemy to spot. *Sammelmitteilung* 1 of July 1944 provides detailed instructions:

"**Camouflage for gliders (not towing aircraft).**
For the duration of the war, gliders and sailplanese will immediately be camouflaged, all parts visible from above and from the side being concealed with aviation lacquer 7174.81 or 82 following the last working process, additionally in accordance with L.Dv 521/2. Camouflage colours will be applied to the upper surface of the aircraft and fuselage and according to the same patching scheme as powered aircraft. If layout diagrams have not already been distributed, these must be obtained from the supply centre N.S.F.K. Worms a.Rh. Airport.

The following new paragraph will be added after Section II D on page 13 of L.Dv 521/2 (please cut out and stick in).

E. Camouflage.
Until further notice, all gliders and unpowered aircraft will be camouflaged. After the paints listed under A. B. and C. have thoroughly dried (approx. 16 hours after the last coating) camouflage is applied with Aviation lacquer 7174.81 or 7174.82 in accordance with the layout diagram.

The paint will be applied only to the thickness essential for the camouflage effect. Aviation lacquers are supplied ready for use. Where necessary, especially when spraying, they are thinned with aviation thinner 7211.00. Drying time: dust dry 1-2 hours, hardening overnight.

Gliders in operation have been or will still be resprayed as an emergency measure pending issue of this Regulation. During this transitional period, aircraft can be sprayed with the existing aviation lacquer 7135 in shades 70 and 71 since it was not possible to produce and supply the above paints in the new shades in good time.

Your attention is drawn to the fact that overspraying with the lacquers indicated may result in changes in the centre of gravity as well as in weight.

Colour charts
RLM shades 81 and 82 cannot be supplied for the present. Delivery checks of the shade will therefore be omitted.

In addition to the above amendment, the following changes must be made manually to L.Dv 521/2:
Page 12: Section II C 1: change aviation lacquer 7102.99 to 'Aviation lacquer 7101.99'
Page 14: Section IIIB (a) 1: change aviation stripper 7210.99 to "Aviation stripper 7209.99"
Page 16: Section IIIC 1.2: change aviation lacquer 7102.99 to "Aviation lacquer 7101.99"
Page 16: Section IIIC 2.1: change aviation stripper 7210.99 to "Aviation stripper 7209.99"
Page 16: Section IIIC 2.3: change aviation lacquer 7102.99 to "Aviation lacquer 7110.99".

Existing stocks of Flw. 7102.99 and Flw. 7210.99 will be used up. However, new orders may be placed only subject to the above amendments."

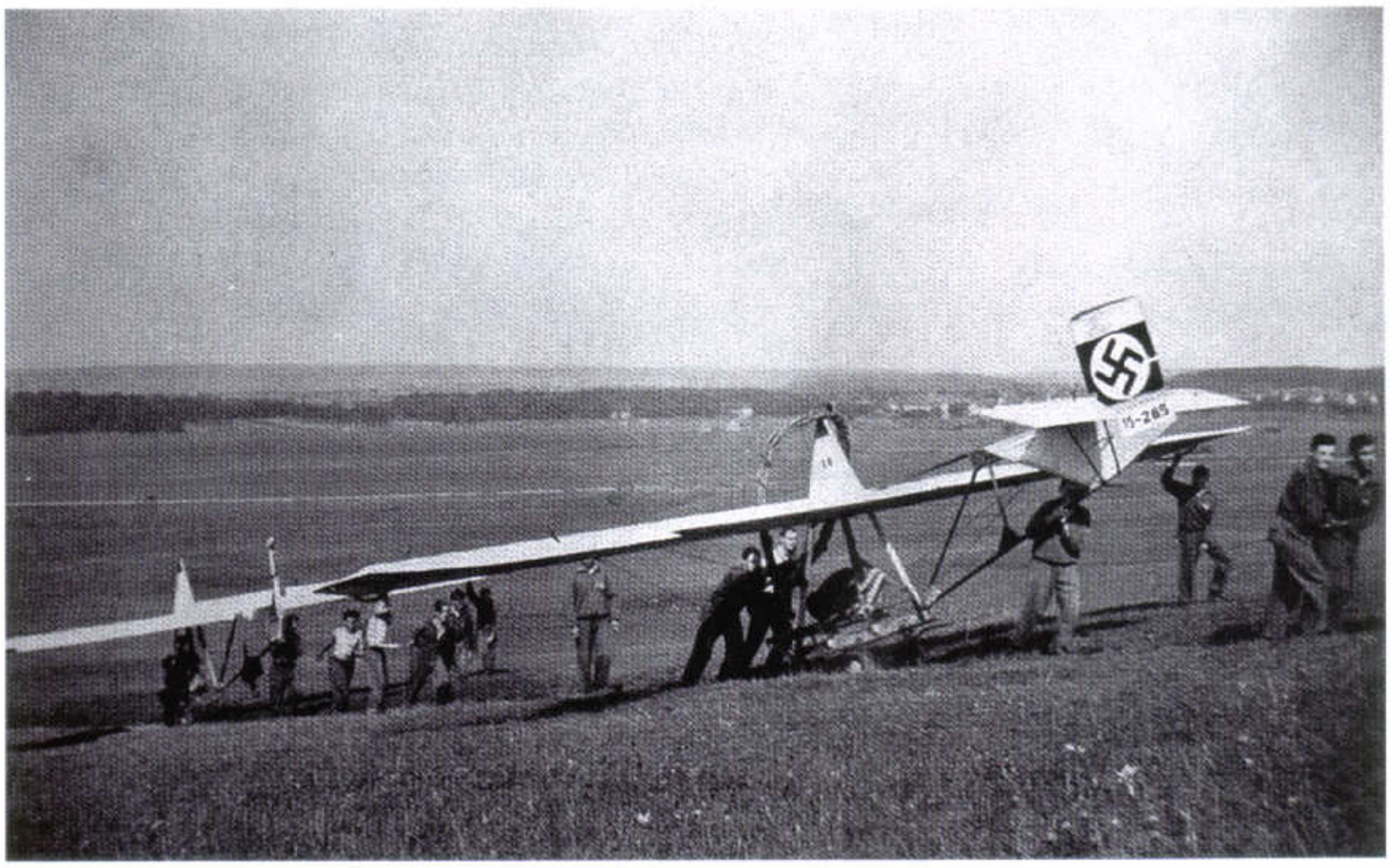
The above quotation contains a number of excerpts that make points worth special attention:

- Aviation lacquer 7174.81 or 7174.82. This *Sammelmitteilung* is one of the first official documents to mention shades 81 and 82. Worth noting is the name of the lacquer – No. 7174. According to L.Dv 521/2 (see chapter 8), this lacquer is to be used exclusively as a coloured wood lacquer for interiors and exteriors in shades 02 and 05. This indicates that the aviation lacquers in shades 81 and 82 were specially produced for camouflaging gliders.

- The change to L.Dv 521/2 without an insert, essentially by hand. Because no insert was produced, this is already remarkable since it strengthens the author's assumption concerning the amendments made to the L.Dv 521 series. It also shows how quickly camouflage for gliders was to be applied since it undoubtedly took months to draft, print and distribute an insert.

- Aviation lacquer 7135 in shades 70 and 71. It is clear from the text, unfortunately without indicating the date, that instructions had already existed before the *Sammelmitteilung* concerning the painting of gliders in shades 70 and 71. According to L.Dv 521/1 (1938 and 1941), the aviation lacquer used, 7135, was intended solely for doping aviation fabric. The instruction that this dope should be used for painting was therefore an emergency measure until the camouflage colours were available in the right lacquer. The new shades 81/82, announced in 1943, were used to produce camouflage colours using aviation lacquer 7174, instead of the old shades 70/71. Logical.

- RLM shades 81 and 82 colour charts. The highlight from the quotation from *Sammelmitteilung* 1 is the sentence that colour charts cannot be supplied for the time being and that the inspection authorities concerned could not therefore check the shade on delivery. This was quite clearly due to the prevailing scarcity of raw materials, which no longer permitted uniform production of an aviation lacquer with its true properties and shades.

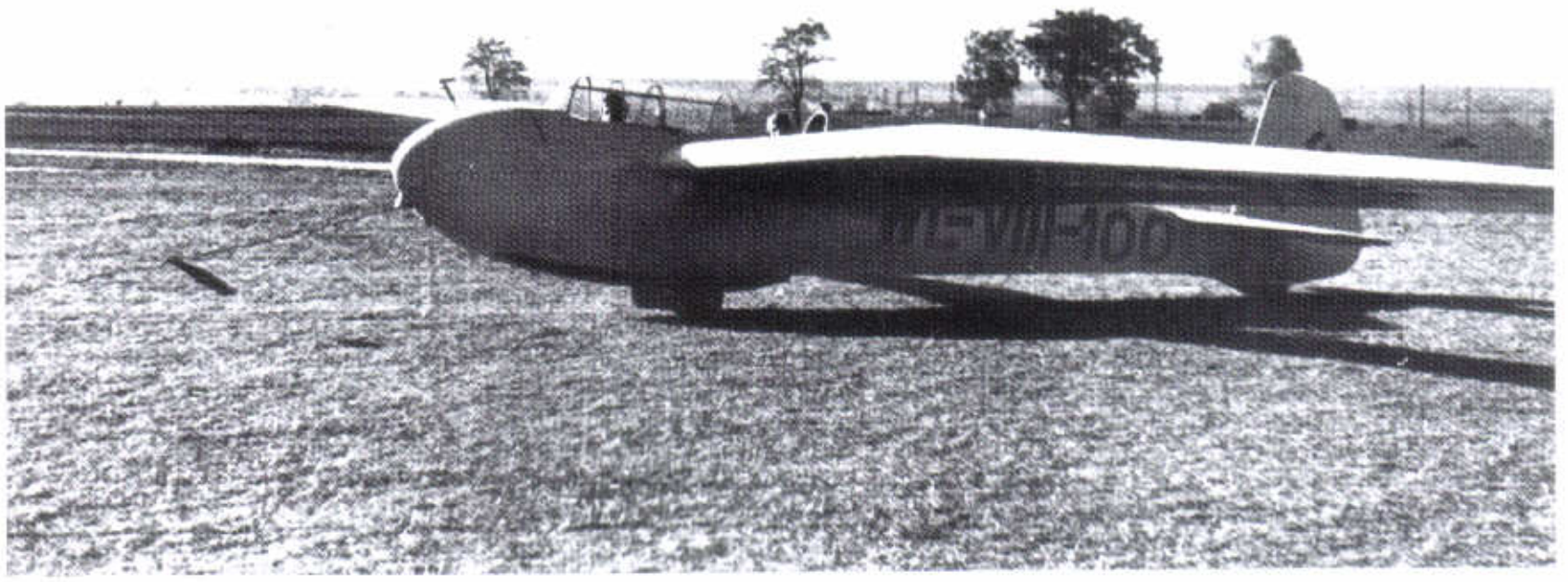


247: *15-285 is an elementary training SG 38 glider in use with the Stuttgart region of the DLV—the Deutscher Luftsports Verband. The materials used in the glider are mostly clear-lacquered or varnished in accordance with L.Dv 521/2 (refer to page 120). The swastika is in line with the diagram shown on page 148*

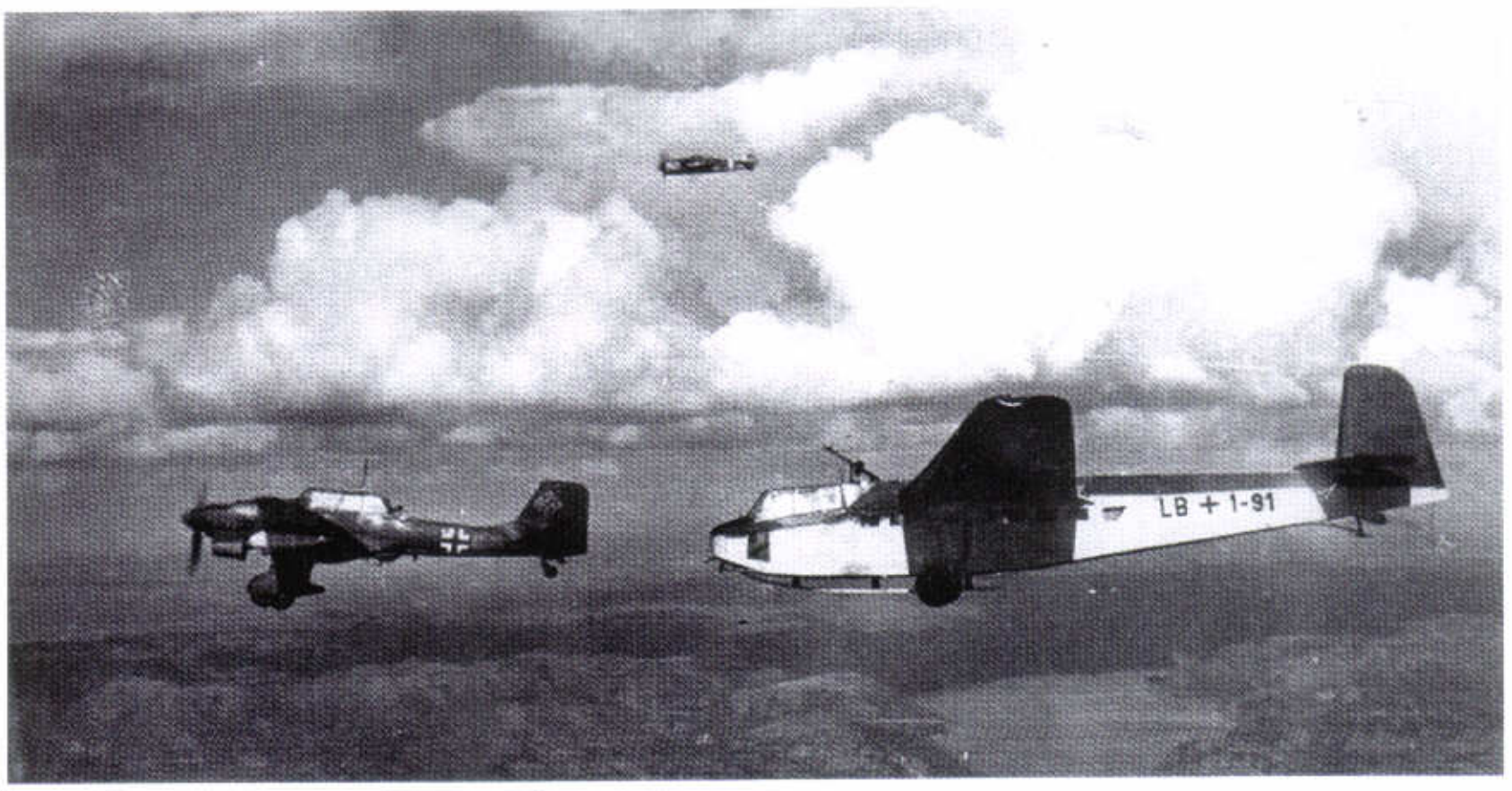
248: *This version of the NSFK-designed SG 38 clearly shows the translucent effect of the clear finishes on the wings; the wing ribs being obvious*

249: *'D-13-532' identifies this glider as a München Milan (?) in service with district 13 (Nuremberg) of the NSFK. It is painted in a clear lacquer on the wings and a light colour on the fuselage, probably a pale cream. It should noted that the NSFK pre-war had its own colours, numbered FAS 1 to FAS 6. FAS 1 was a pale cream, lighter than RLM 05, and close but not identical to, modern RAL 1015. All markings are in conformity with official requirements. 'D-13-531' is a Göppingen Gö 1 Wolf. It carries the NSFK emblem on the fuselage below the cockpit*

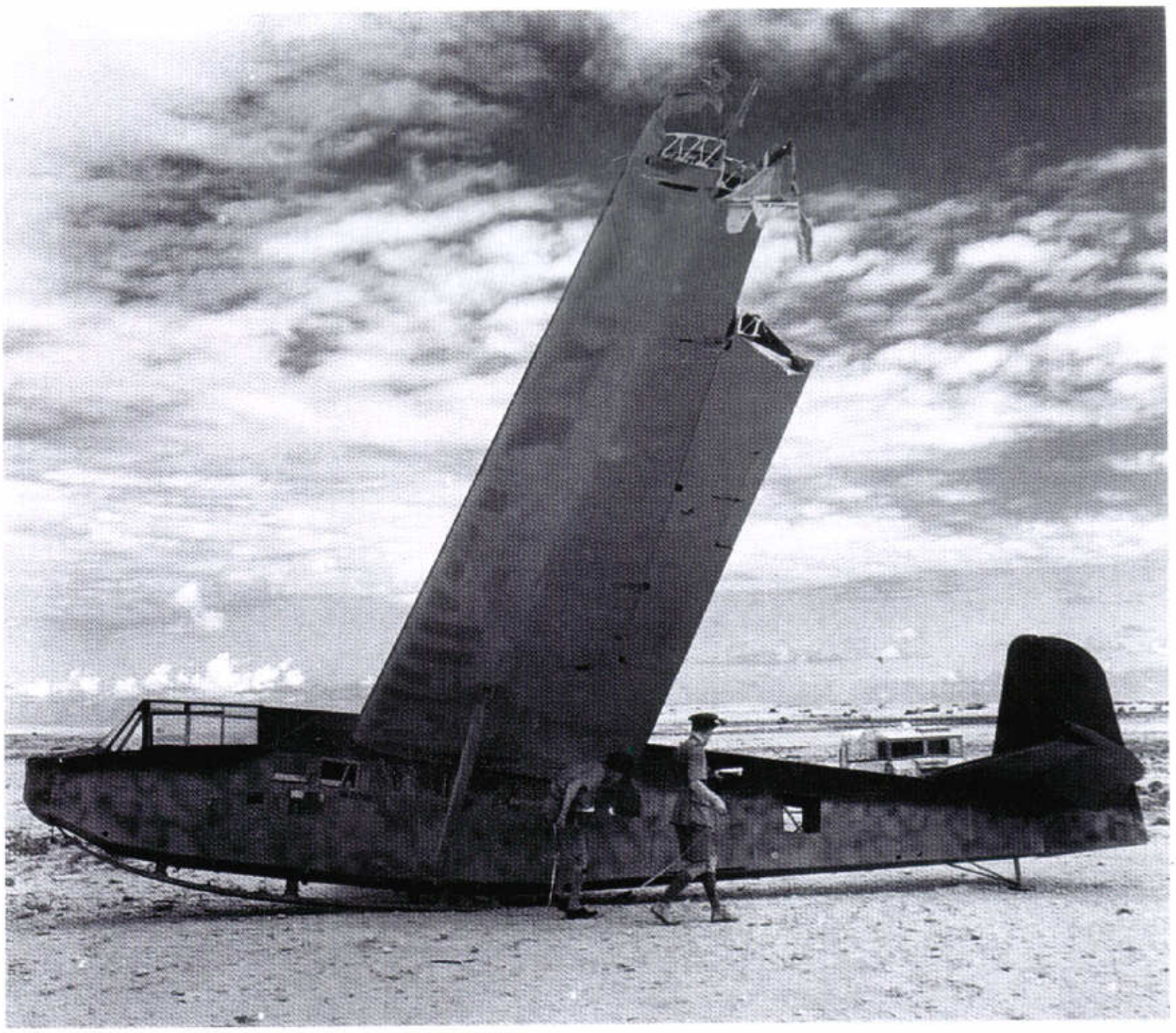
250: *A more sophisticated Rhönsperber in Luftwaffe markings, as indicated by the 'WL' code, dating from 1 January 1939. (See page 150). On Luftwaffe training gliders this style of marking remained in use well into the war. As shown here, the glider is finished in 05 cream*



251: *This DFS 230 of II./ LLG 1 being towed by a Ju 87 on a training mission over France wears an early style of markings applied to the Luftwaffe's troop-carrying gliders. The Ju 87 and the escorting Fw 190 are in standard colours, while the glider appears to be in an overall dark green on the uppersurface and 65 below. Large numbers of gliders were assembled in southern France in summer 1943 in anticipation of an Allied invasion. In the event it took place in Sicily*

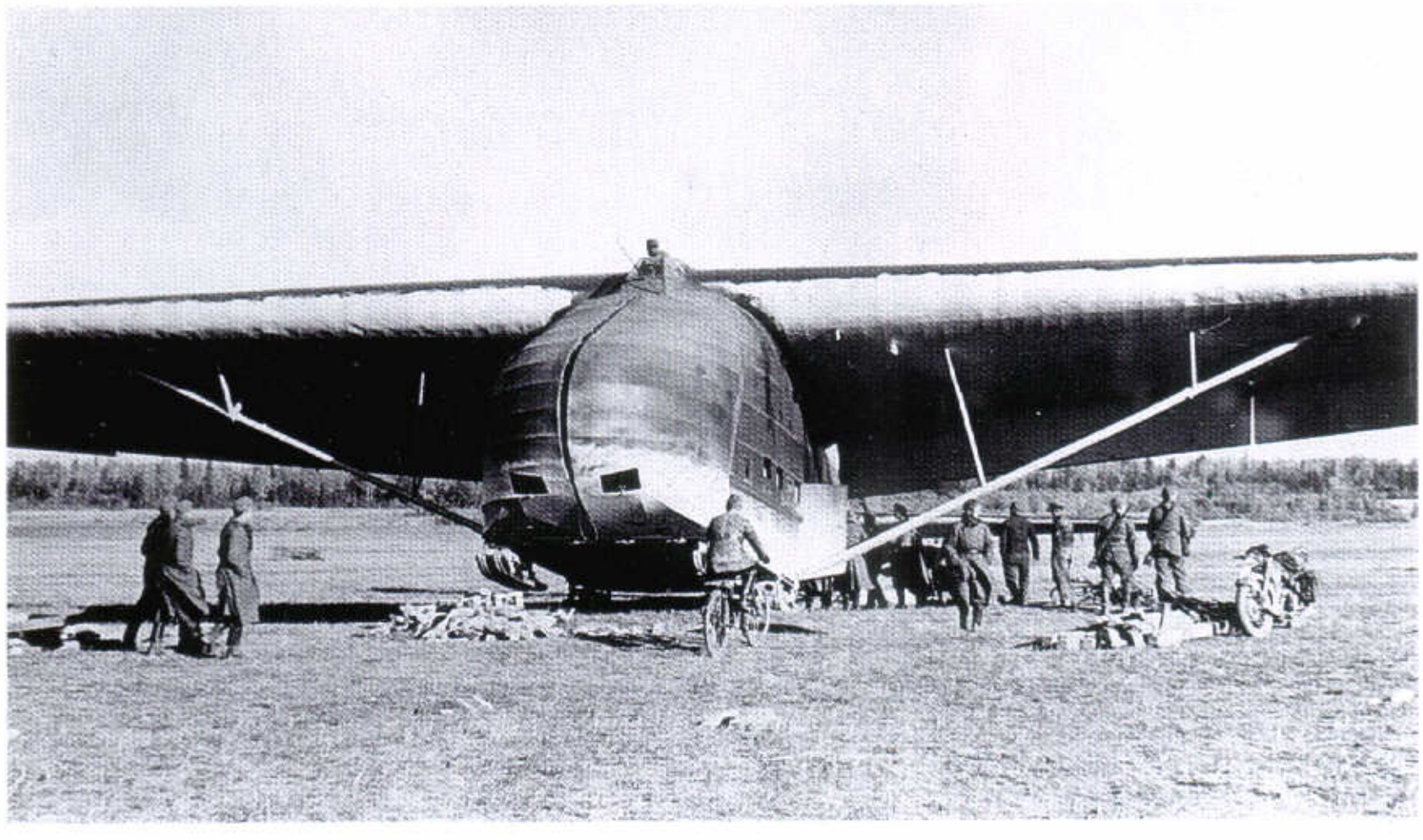


252: *This abandoned DFS 230 was found behind Allied lines in Tunisia in 1943. It had been used to land German commandos. It wears no national markings and from this angle appears to be finished in 70/71 on the uppersides but the lower surfaces appear too dark for 65. This may be 02 but could it possibly be 78 Hellblau?*



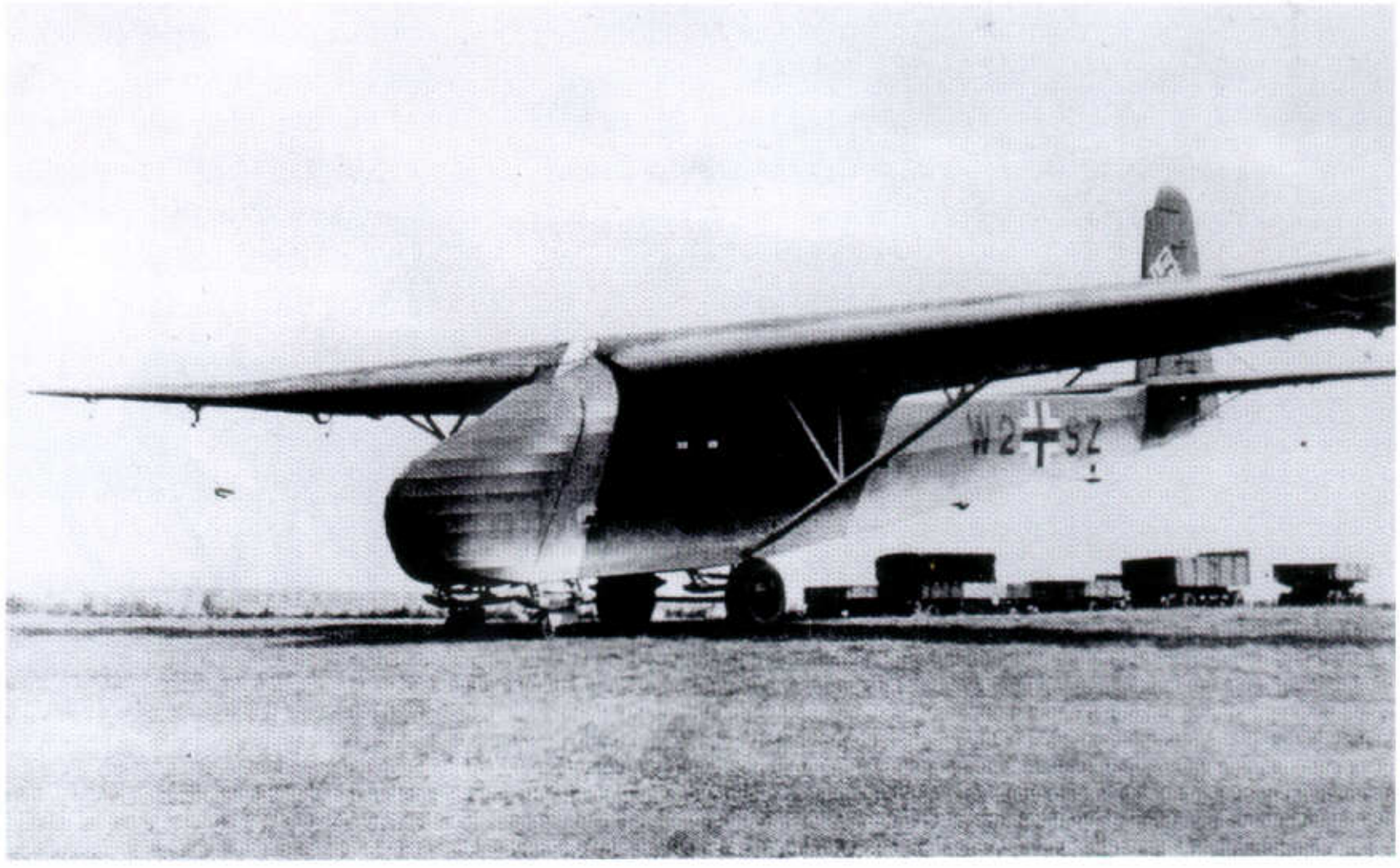
253: *A starboard side view of the same DFS 230 seen in photo 252 shows it to be finished in at least two, and possibly three, colours on the uppersurfaces. Most likely 70/71, the very matt finish is noteworthy, as is the total absence of any national or unit markings*

254: *This DFS 230 from LLG I or II was also abandoned in the Wesern Desert. Finished in the same colours, probably 70/71/65, as others of the type, it also carries unit and national identity markings. The very small size of the markings was probably chosen to both enhance the confusion caused by glider landings among enemy positions and also to assist the camouflage*

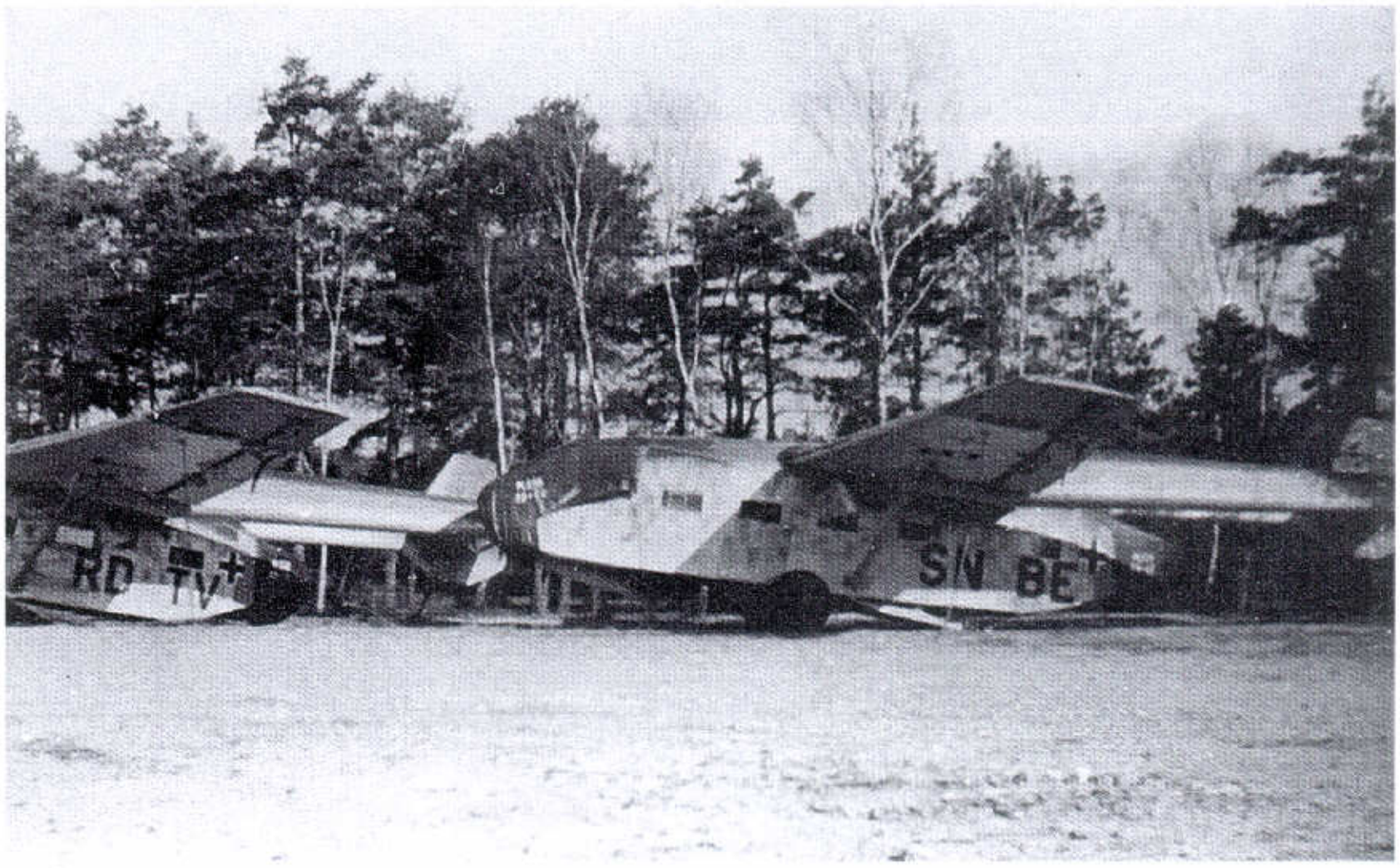


255: *A very rare Me 321A-1, W2+SH, of Baureihe der Me 321 reveals both its enormous size and the bright tone of the 65 undersides. Uppersurfaces were 70/71*

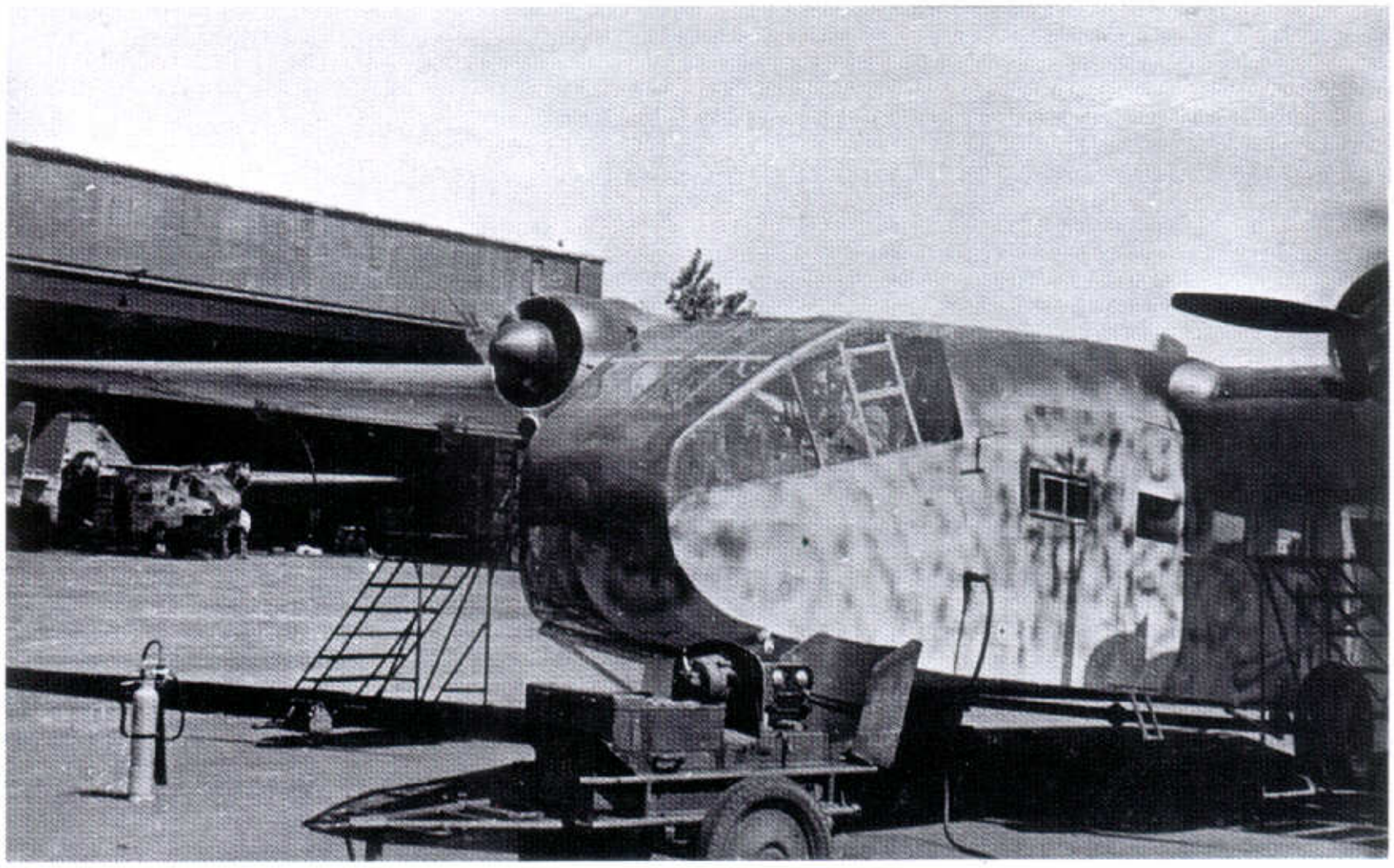
256: *Another Me 321A-1, W2+SZ, of Baureihe der Me 321 with gigantic national markings on the 70/71 finish*

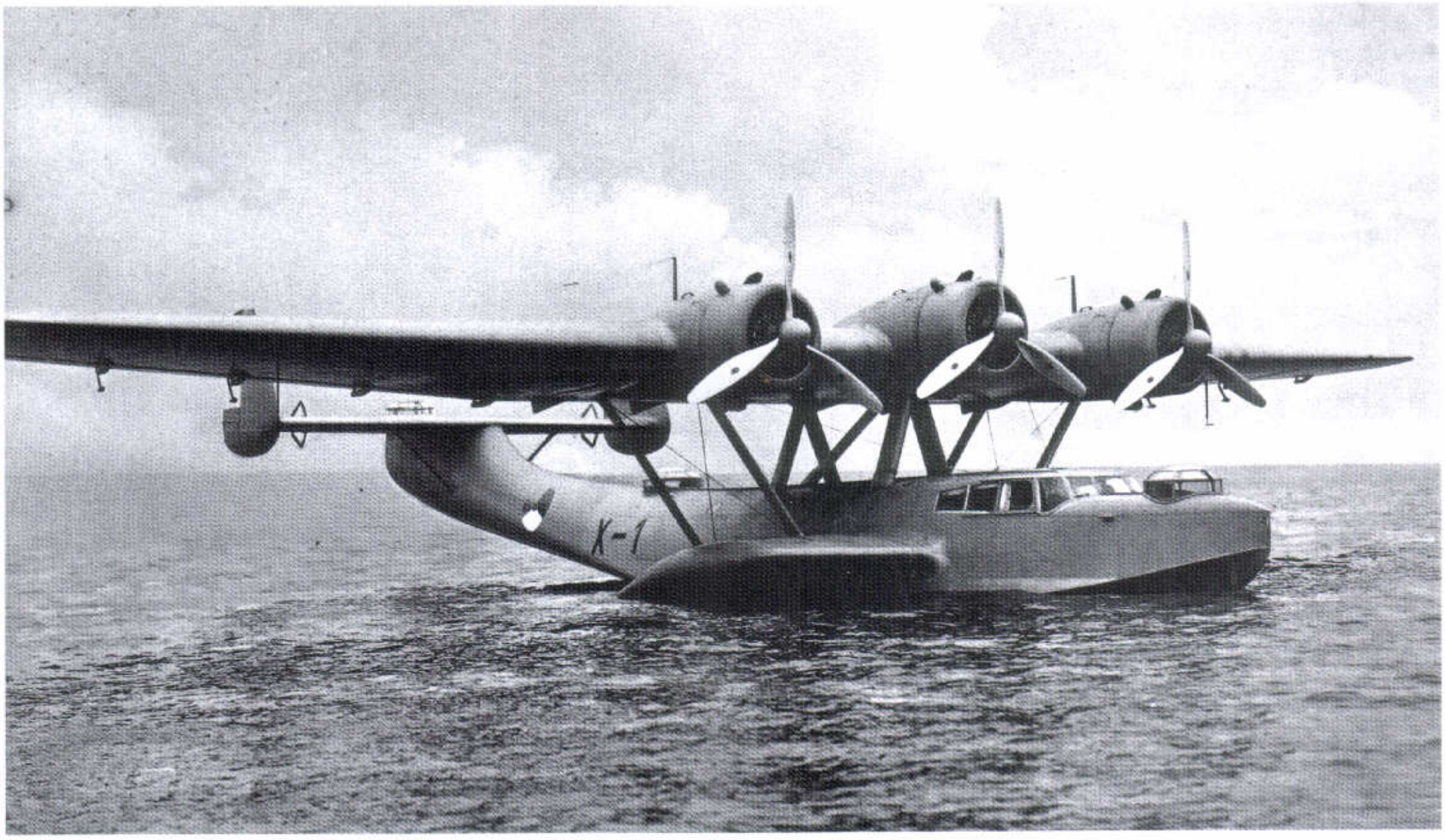


257: *These Go 242s at Stendal appear to be finished in a higher contrast camouflage scheme; possibly 71/02? The yellow undersides to the wingtips identify use on the Eastern Front. Balkenkreuz and codes are in standard styles*



258: *This Gotha 244, the motorised version of the Go 242 was also at Stendal. Judging by the tone of the 70 Schwarzgrün spinners, the rest of the uppersurfaces were probably finished in 70/71. The very light fuselage sides have been lightly mottled in the uppersurface colours*





'EXPORT COLOURS'

Old colours under new names?

This term is used here solely because it has been widely adopted by collectors and others, although it is the author's opinion that the precise term never existed.

During the pre-war period, the German aviation industry supplied numerous aircraft abroad. For example, Junkers supplied Ju 86s to Sweden and Dornier supplied Do 24K patrol flying boats to the Netherlands for use in the Dutch East Indies. These aircraft were supplied in accordance with the customer's requirements. The paints in which they were finished *may* have had a different shade from the RLM standard.

On 4 October 1937 the following colours were used for the Do 24 K according to the surface protection list:

Interior:
DKH oil base green L 40/41
DKH nitro top coat silver L 40/51

Exterior:
Above water W No. 761, 762, 765 – 778 (X-1, -2, -5–18):
Ikarol light metal primer green 201
Ikarol top coat I grey 103/1
Ikarol top coat II Hollandgrau 103/2

Or, for Werk Nrs. 763 and 764 (X-3, -4):
DKH oil primer green L 40/41
DKH nitro top coat grey L 50/51
DKH nitro enamel Hollandgrau L 40/52

Underwater:
Ikarol light metal primer 201
Ikarol top coat I grey 103/1
Ikarol top coat silver III/S

The paints used from Warnecke & Böhm recur in L.Dv 521/1 of 1938 as aviation lacquer group 02. DKH lacquers are similarly known from various OS lists of other aircraft types.

The product designation topcoat 103 from Warnecke & Böhm describes the product properties. Topcoat 103 was a two-layer surface protection paint. /1 indicated layer 1 and /2 was the topcoat layer 2, which also designated the shade of lacquer. These additional designations are not the actual designation of the shade (e.g. /2 = RLM Grau 02 according to RLM). The shade of the topcoat is indicated in the description of the paint. This procedure was identical for DKH and Ikarol. The designation Hollandgrau was adopted to distinguish this grey from the dozens of grey shades that were available. According to Dutch sources, however, Hollandgrau was identical to RLM Grau 02. •

259 Above: *The picture shows the first Dutch Dornier Do 24. It is very easy to see that the underwater coating is silver, in accordance with the surface protection list. The shade designated Hollandgrau appears much darker than the usual light grey on German flying boats. RLM Grau 02 would give such a tonal difference compared to L40/52 or 63*

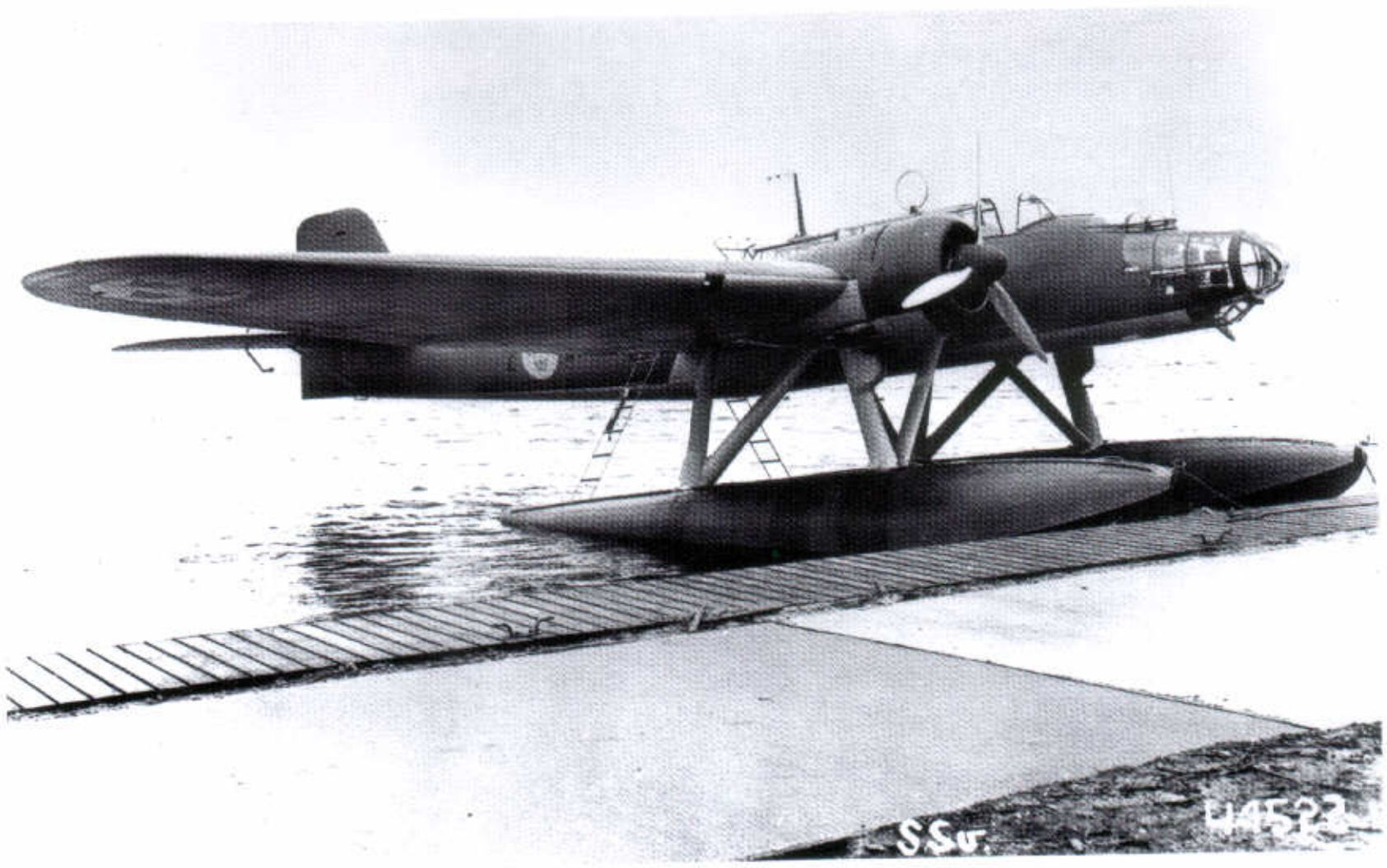
Now, as then, the paints industry supplies its products in any desired shade since shades are produced by pigments while the other components of a paint remain unchanged. The shades Hollandgrau and RLM grey 02 can therefore be identified for product 103 at Warnecke & Böhm. Hollandgrau, Duralgrau, Bronzemittelgrau, grau, schwarz and silber are similarly names for the product DKH L 40/52.

According to Swedish sources, their Ju 86s were delivered in standard 61/62/63 uppersurfaces, in a pattern prescribed by the Swedes. The later sand brown, grey and green (Mörkbrun W54, Olivgrün W25 and Ljust Gulgrå W55) colours used were applied in Sweden after trials in 1940. Anecdotal evidence from Hungary states that, lacking their own modern paint industry, all their aircraft were finished in standard Luftwaffe or Italian paints, often in combination. Bf 109 fighters delivered to Switzerland were definitely all finished in standard 70/71/65 or 74/75/76. Available evidence from Norway states that their He 115s were delivered in 1939 in overall RLM 02. Yugoslavia received over 70 Bf 109E-3s. The only information available concerning the colours of these states them to have been 'black-green' on the upper surfaces. Photos show the propeller spinners and airframes to be in very similar tones, so this may mean RLM 70. Dornier 'Wals' in Yugoslav service are stated to have been finished RLM 63 Hellgrau.

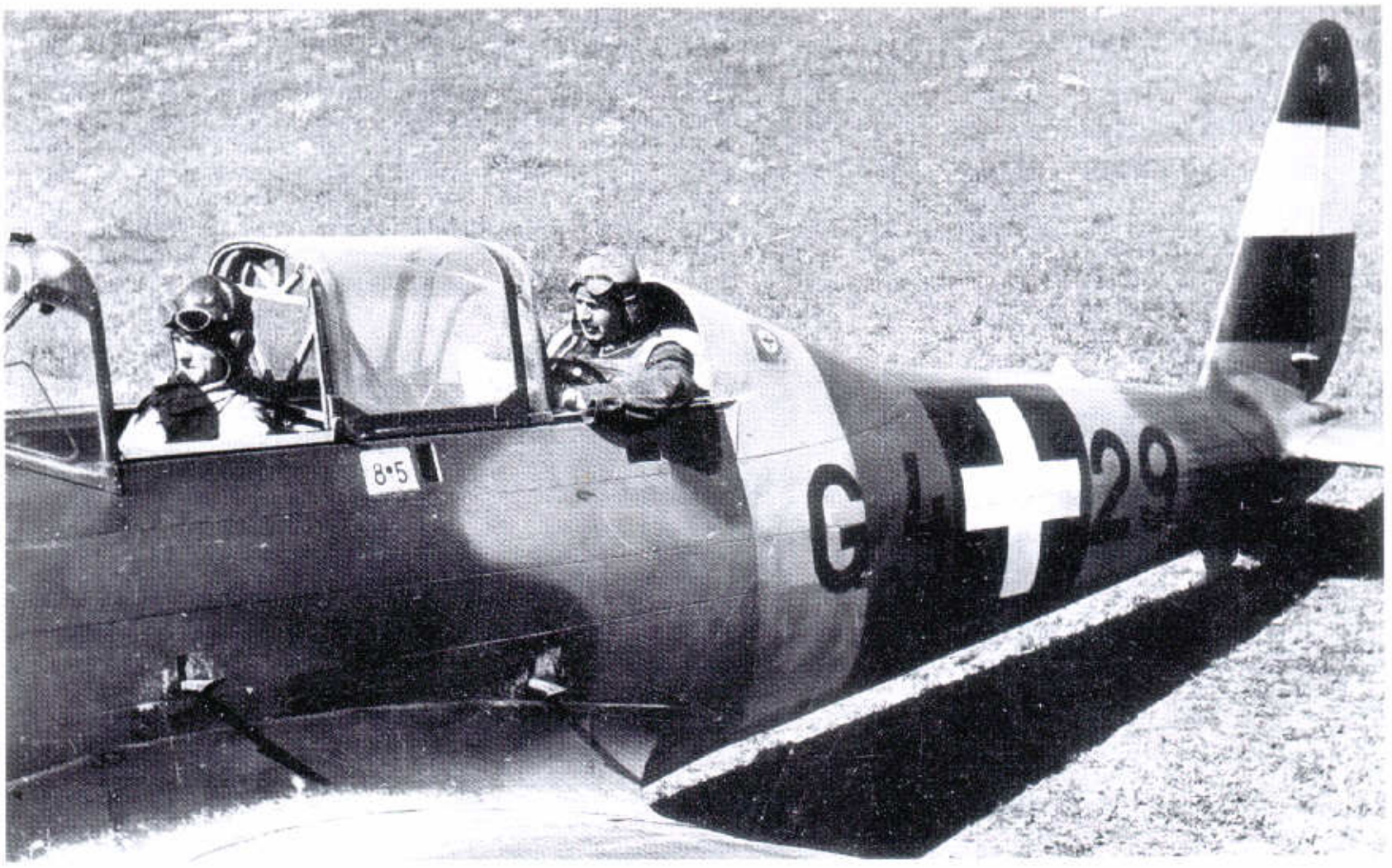
Despite the fact that much hard information is still missing, it appears quite possible that in fact 'export colours' never existed and that names like 'Hollandgrau' were only cover names for RLM colors such as RLM Grau 02. The reference to RLM 70/71 on page 219 shows that such a practice was usual during this time period.

Presently the author has no further information about 'export colours' and especially about the shades. It is a fact, however, that a substantial number of different shades existed outside the RLM numbering (in the RAL range for instance) for the various products. It is hoped that more particulars will surface on this interesting topic in due course.

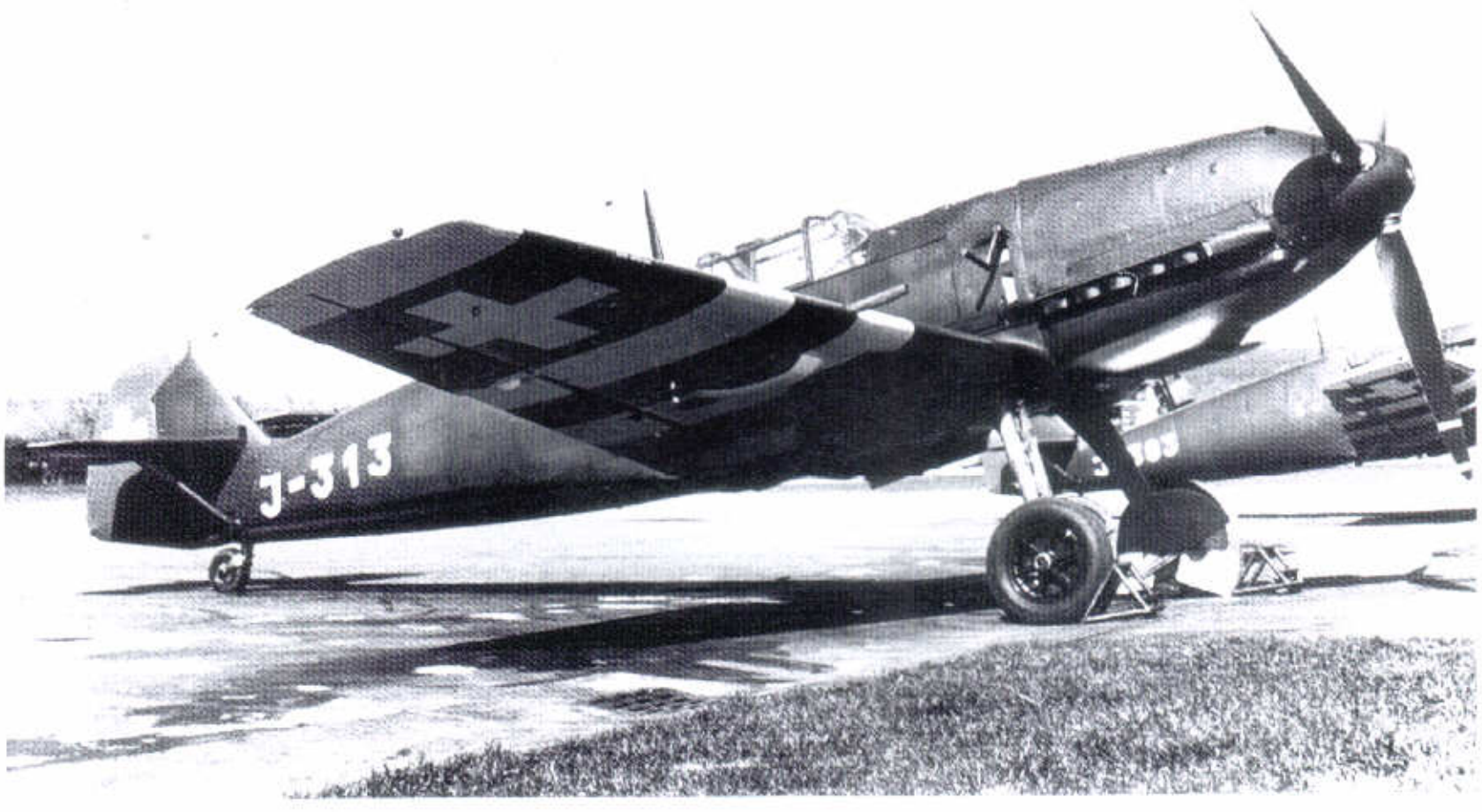
260: *This Dornier Do 17Kb in Yugoslav colours is one of the two Yugoslav-built examples, Nos 3348 and 3363, which escaped to Egypt after the invasion of April 1941. Minus most Yugoslav markings, it still retains its original camouflage. According to Yugoslav sources, these paints were supplied by IG Farben and consisted of a Laubgrün base with patches of Pompeianisch (dark brown), Zug Grün and Gelb (yellow ochre). Undersides were silver or Hellgrau. True export colours or cover names?*



261: *This is the first He 115A-2 to be accepted by the Swedish Flygvapnet (Air Force). Known as the 'T2' in Swedish service, the aircraft is coded '2-21' and is wearing a simple camouflage of olive green and light blue-grey. The Swedish requirement for the uppersurface was intended to be a 'brown-grey' but in the event the same green as used on the B3 (Ju 86) was used i.e. RLM 62. Undersides were 65. Additionally, the float undersides were meant to be yellow. Thus, according to Swedish sources, their German-supplied aircraft arrived in standard German colours in Swedish patterns*



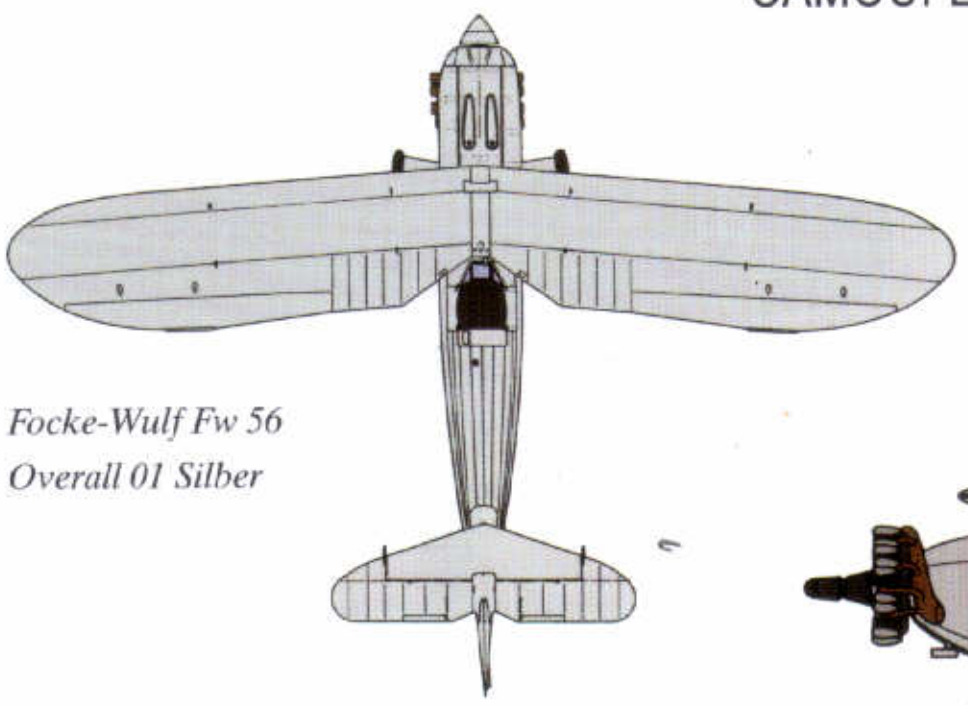
262: *Seen on the Don Front in September 1942, this Hungarian-operated Arado Ar 96A displays a typical Hungarian camouflage pattern. This appears to be the basic 70/71 colour with flowing patches of a light sand over the top. This is most probably of Italian origin as the Hungarians used almost equal quantities of Italian and German aircraft—and the appropriate paints. Note the yellow Eastern Front theatre band and the red/white/green Hungarian stripes on the tail*



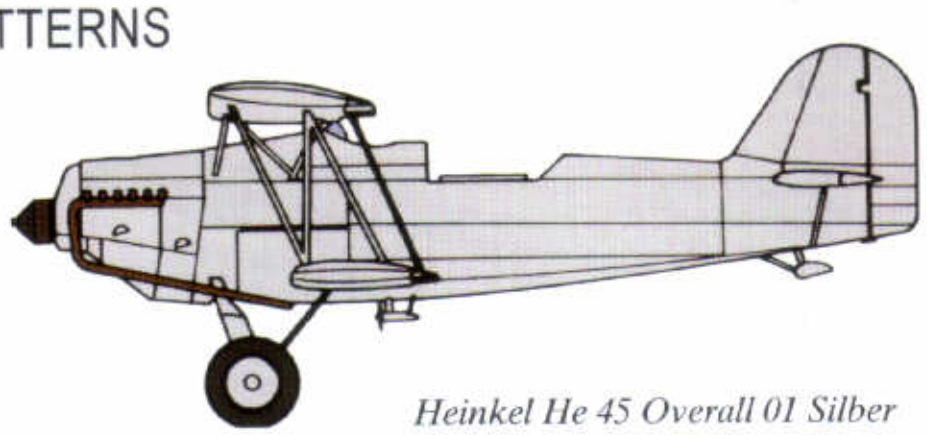
263: *'J-313', WNr 2161, was one of the earliest Bf 109E-3s to be delivered to the Swiss Flugwaffe (on 20 June 1939) and was finished in standard 70/71/65, as were all the Bf 109Ds and Es delivered to Switzerland. As seen here in post-war style markings with the red and white wing bands, the original finish has been overpainted an overall green. The later Bf 109Gs sold to Switzerland were all finished in entirely standard 74/75/76 in accordance with the OS Liste*

264: *One of eight Dornier Do 22 See floatplanes to escape from Yugoslavia in April 1941, '306' survived operations alongside the RAF 230 Squadron until April 1942. Operating from Aboukir in Egypt, the aircraft is seen here being loaded with bombs by RAF groundcrew. As delivered the aircraft wore an overall grey camouflage with black fuselage numbers. Judging by the tone this might have been 02 but the stripes were probably applied using RAF paints (Dark Green?)*

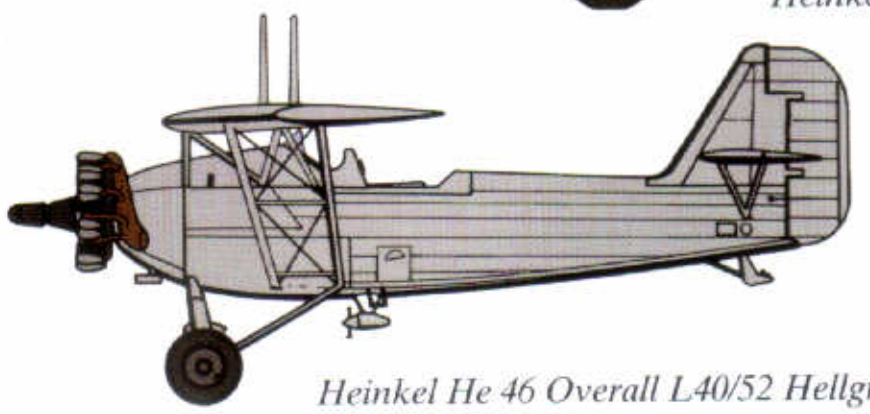
CAMOUFLAGE PATTERNS



Focke-Wulf Fw 56
Overall 01 Silber

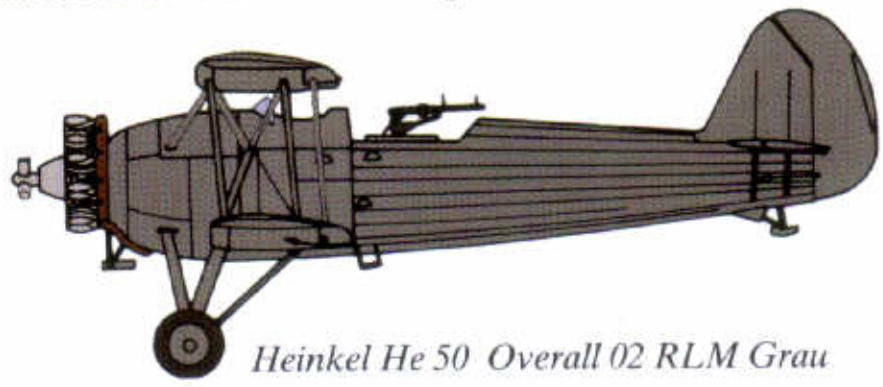


Heinkel He 45 Overall 01 Silber

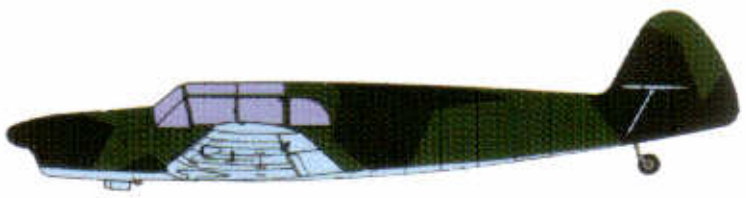


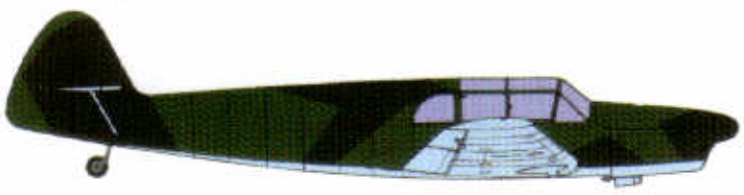
Heinkel He 46 Overall L40/52 Hellgrau or 01 Silber

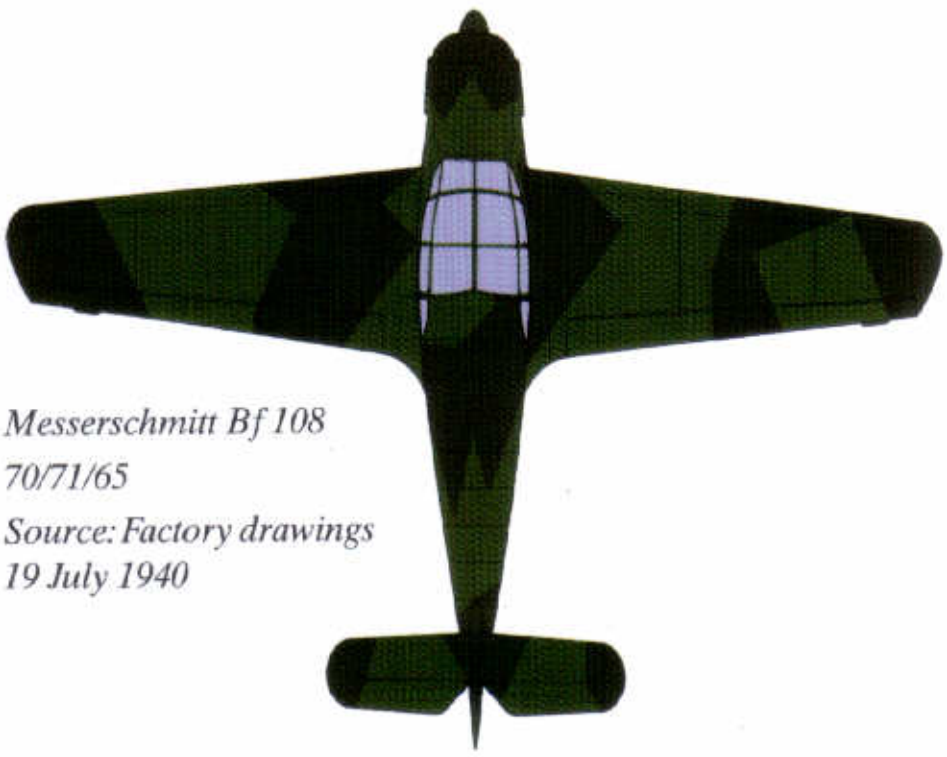
Early Luftwaffe aircraft were almost all painted overall in one of the three shades shown here. Refer to text for more details



Heinkel He 50 Overall 02 RLM Grau

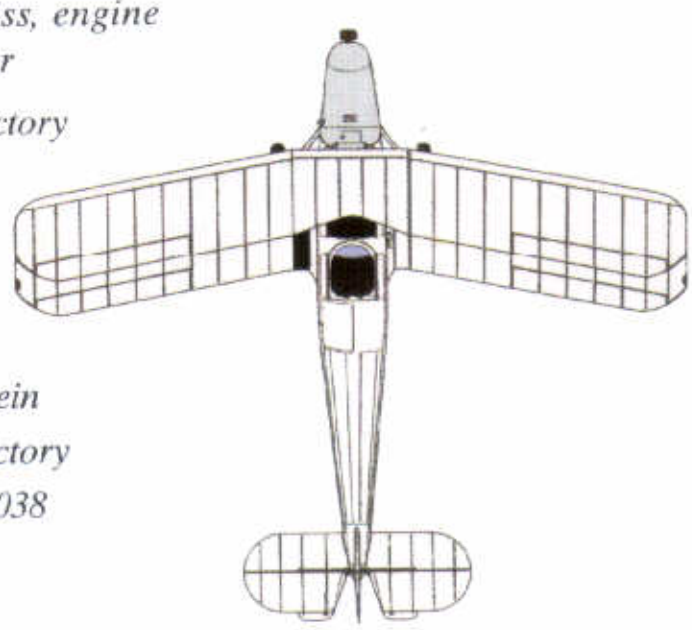




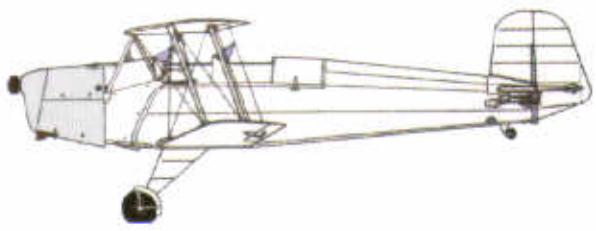


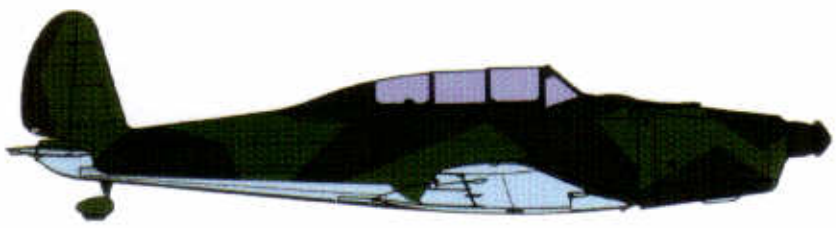
Messerschmitt Bf 108
70/71/65
Source: Factory drawings
19 July 1940

Bücker Bü 131A/B
Overall Perleweiss, engine cowling matt Silber
Source: Bücker factory documents

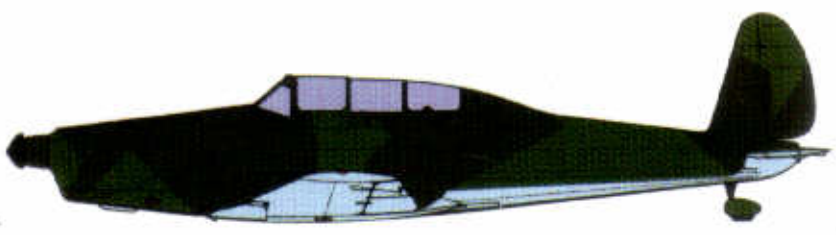


Bücker Bü 131D
Overall 05 Elfenbein
Source: Bücker factory document BüN/B038
18 July 1939



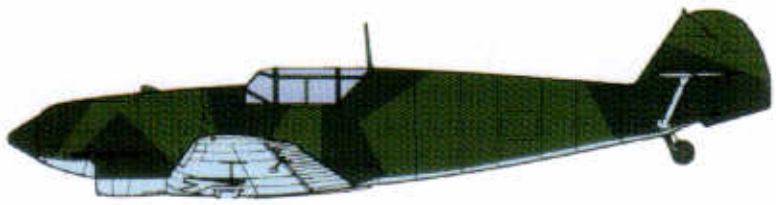


Arado Ar 96B
70/71/65
Source: Letov factory drawings

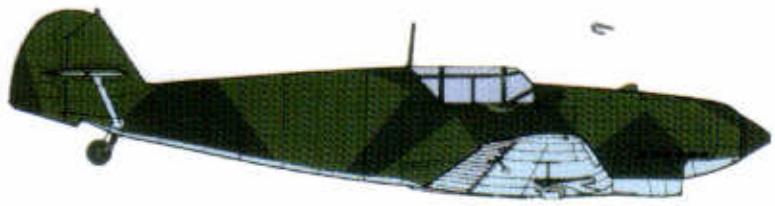


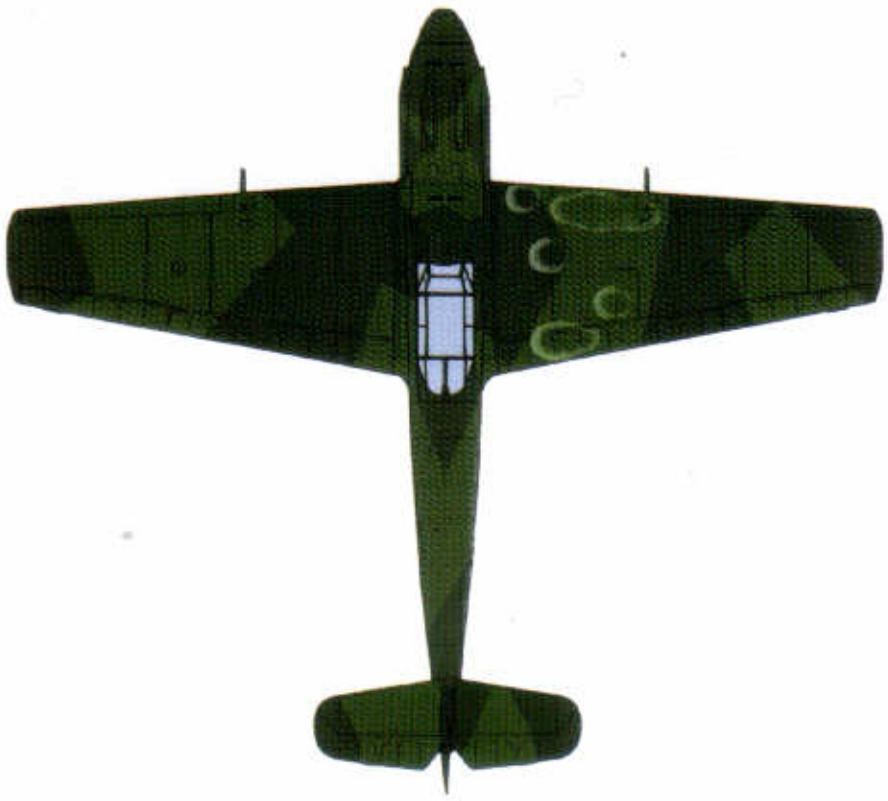
1/144 SCALE

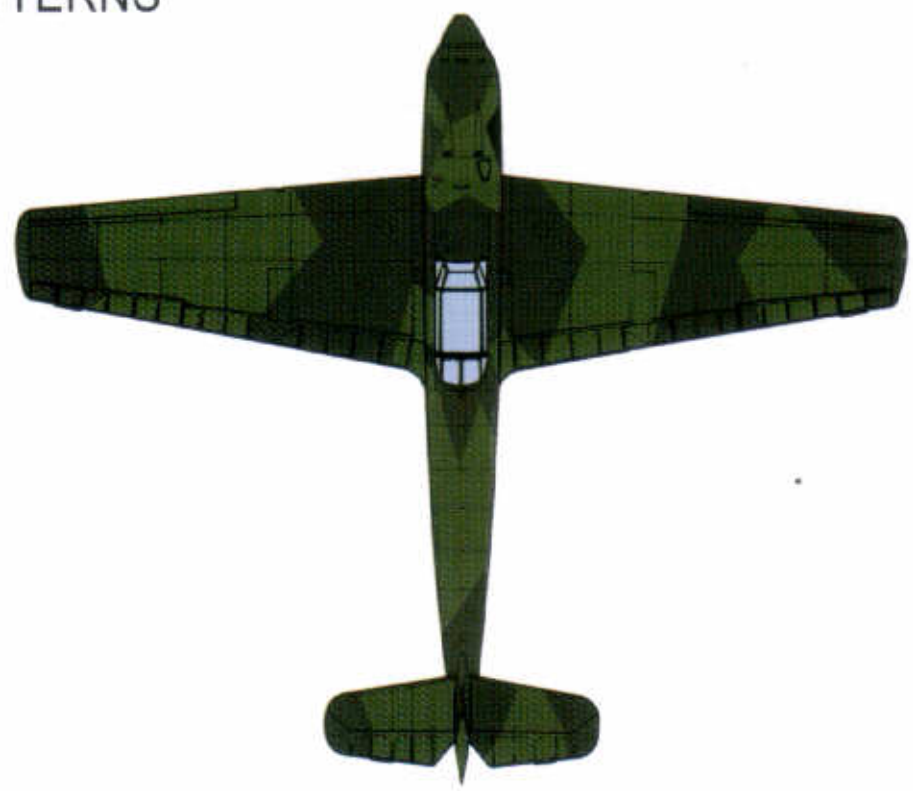
CAMOUFLAGE PATTERNS



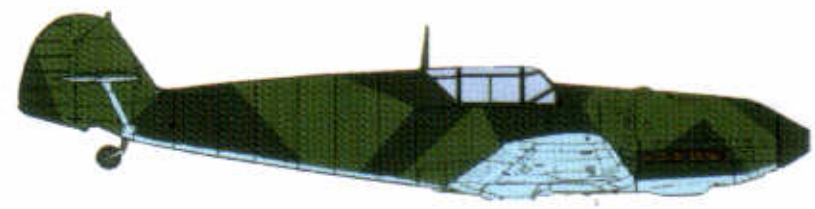
Messerschmitt Bf 109B
70/71/65
Source: Factory drawings February 1937

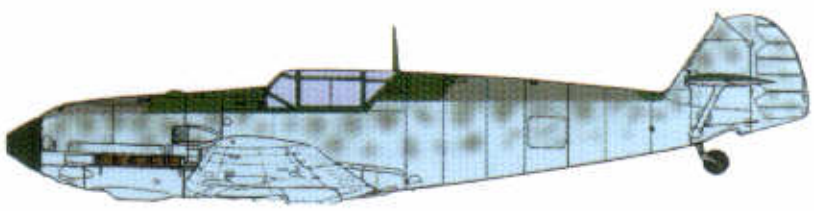


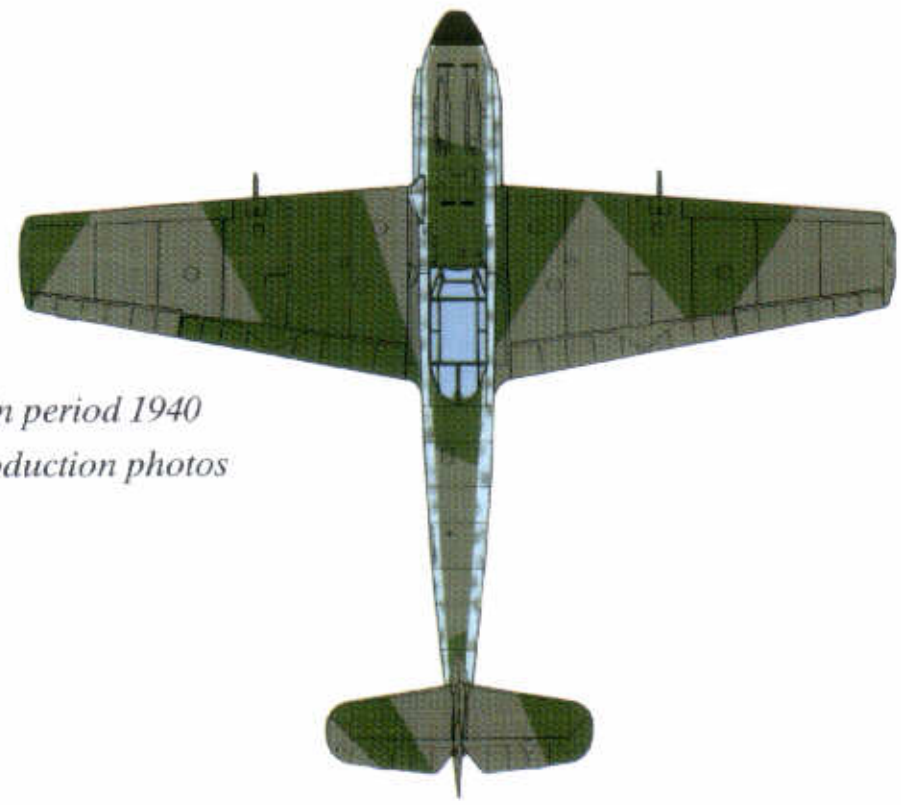




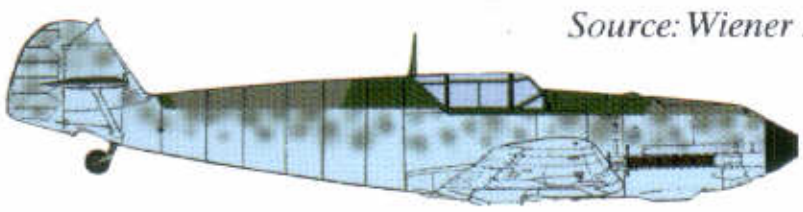
Messerschmitt Bf 109E
70/71/65
Source: Factory drawings February 1937

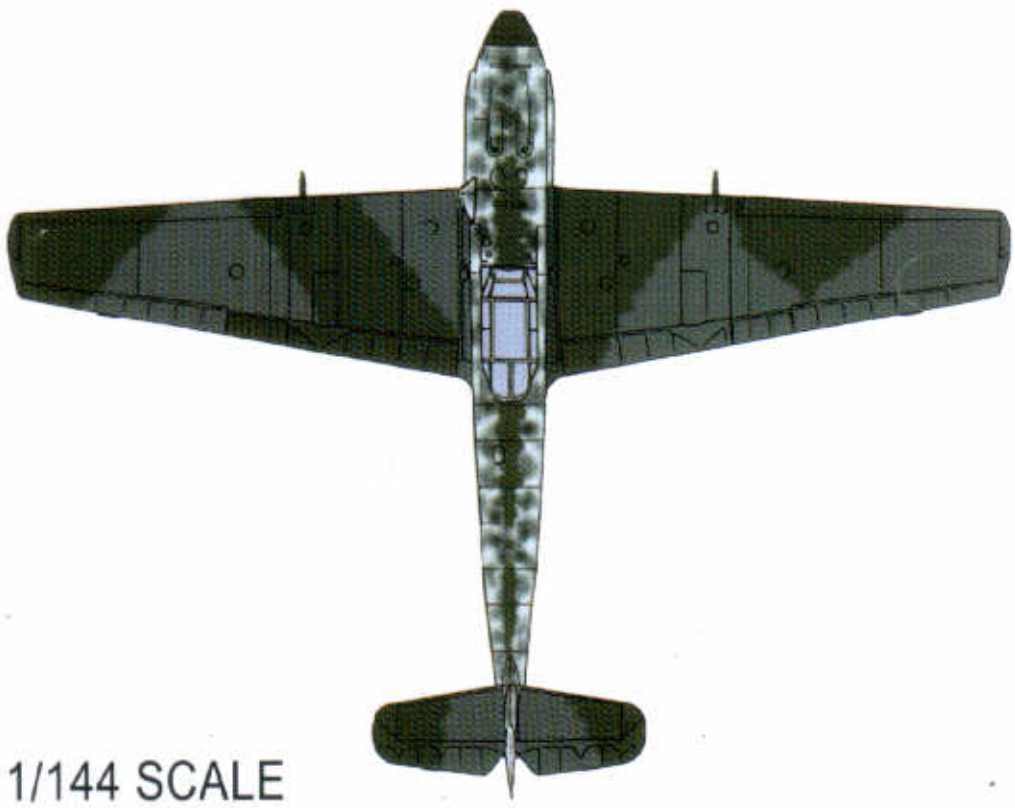


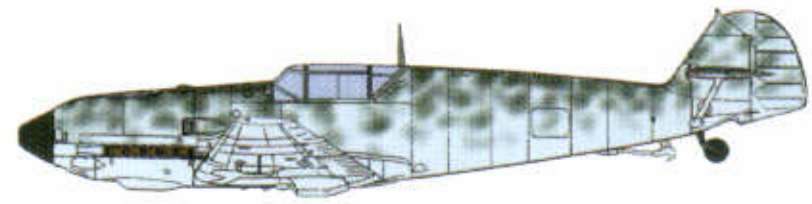




Messerschmitt Bf 109E-4, E-7
71/02/65. Typical for Battle of Britain period 1940
Source: Wiener Neustadt factory production photos



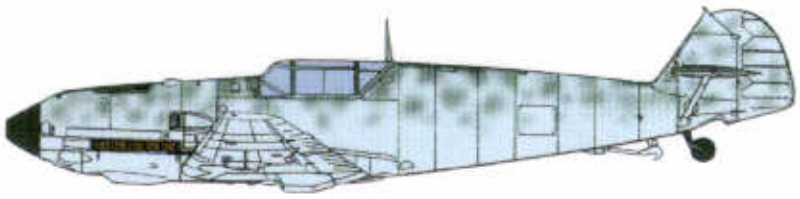


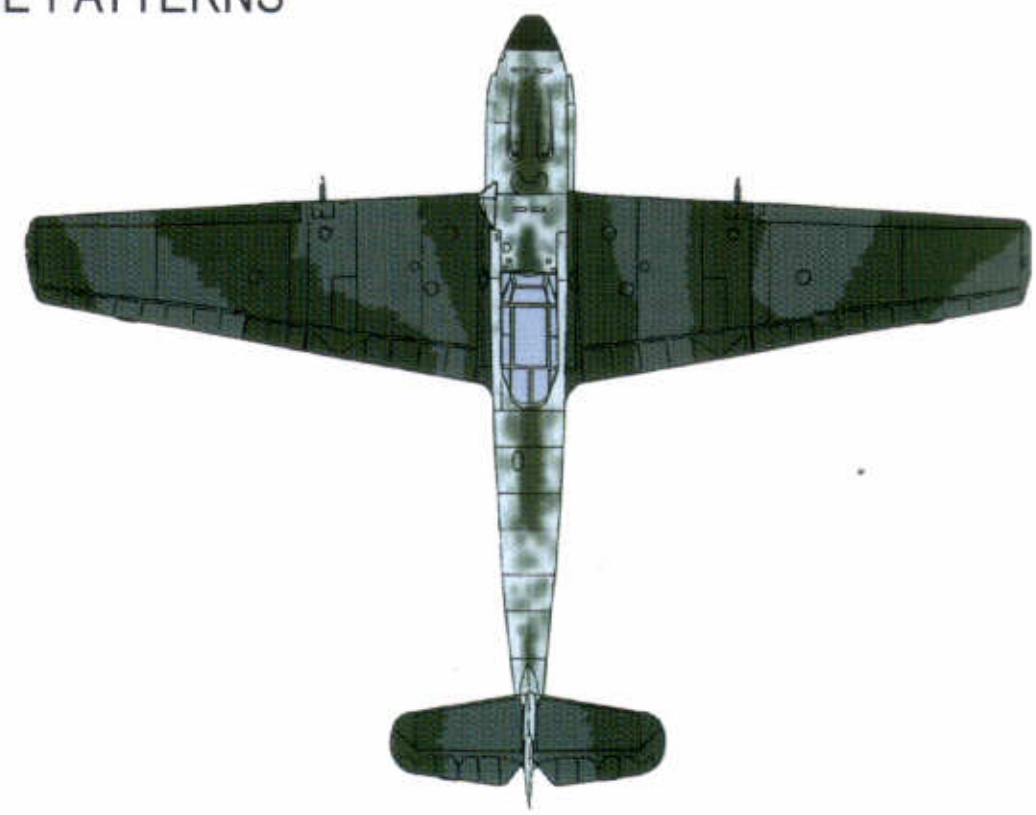


Messerschmitt Bf 109T 'dark' scheme
74/75/76
Source: Photos

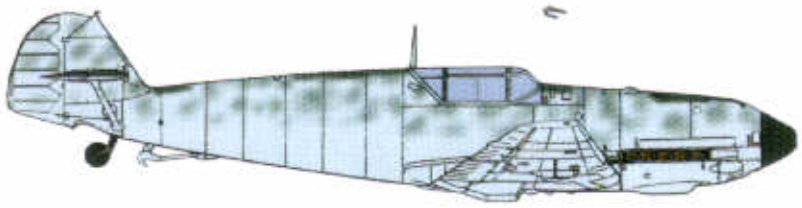
1/144 SCALE

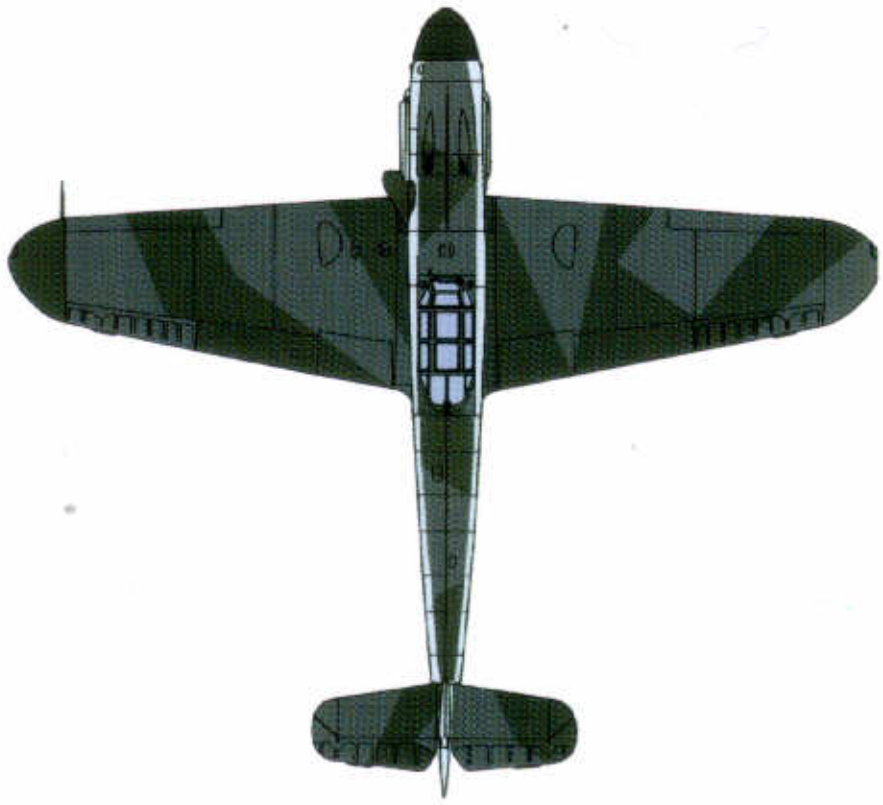
CAMOUFLAGE PATTERNS



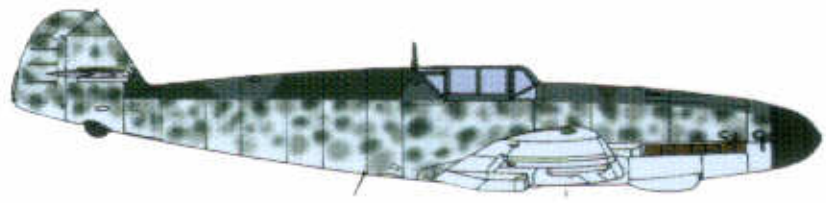


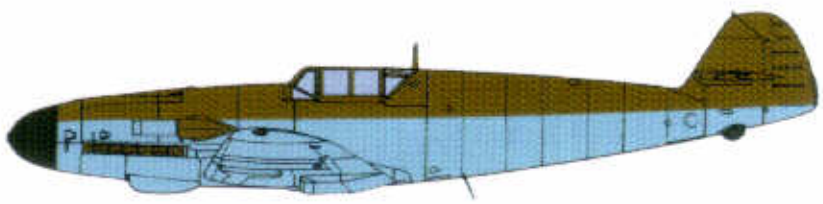
Messerschmitt Bf 109T 'light' scheme
74/75/76
Source: Photos

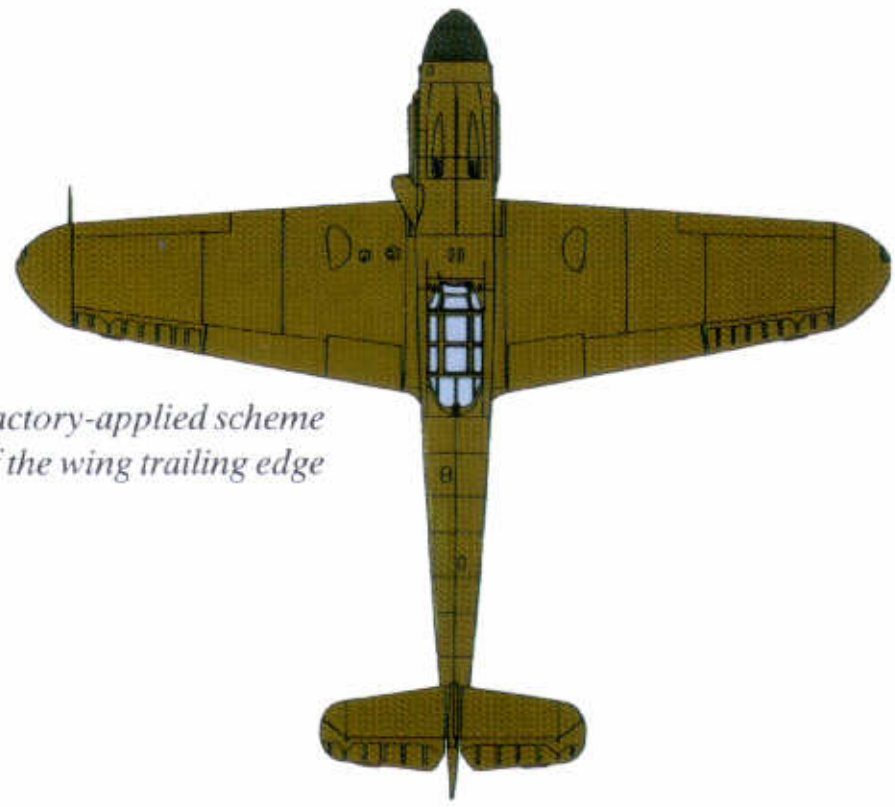




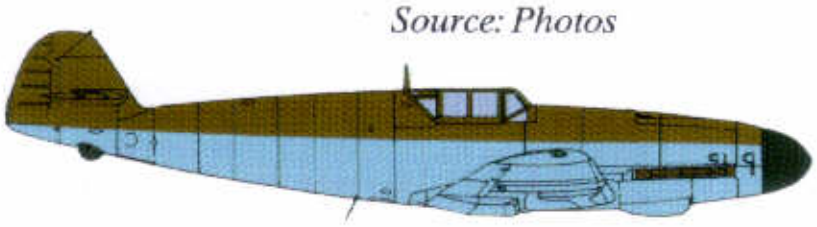
Messerschmitt Bf 109F
74/75/76 with 70 and 02 blotches
Source: Factory drawings August 1941

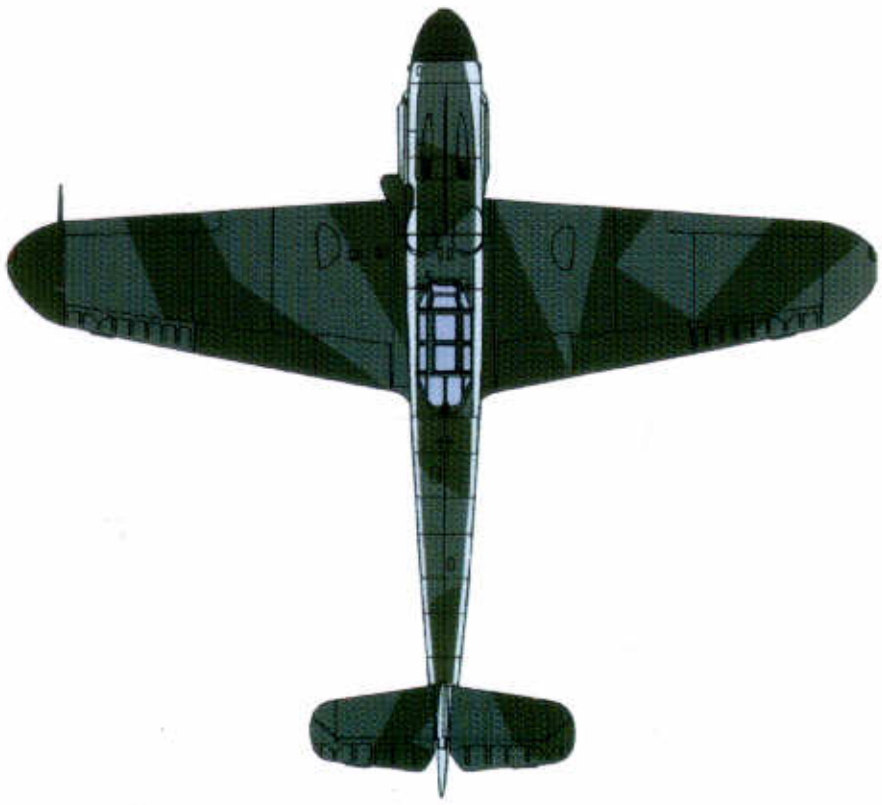




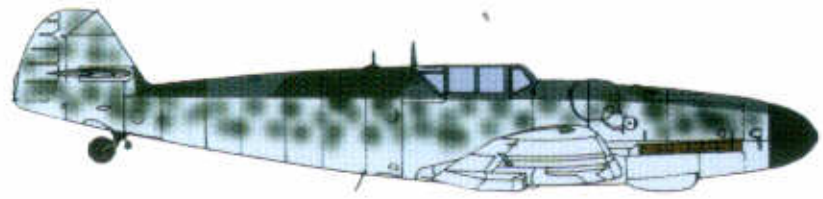


Messerschmitt Bf 109F and early G
Tropical scheme 78/79. On some aircraft the factory-applied scheme covered the fuselage sides down to the level of the wing trailing edge
Source: Photos





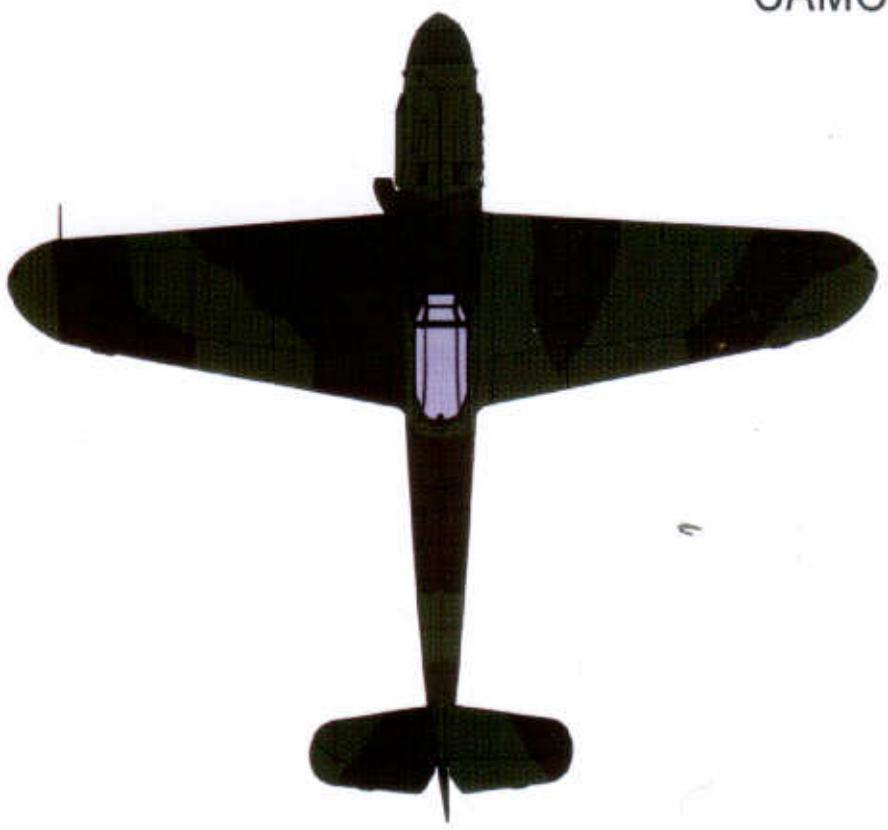
Messerschmitt Bf 109G (early)
74/75/76 with 70 and 02 blotches on the fuselage
The spinner was 70 with one third in 21
Source: Factory drawing OS Liste 8-109 G.a

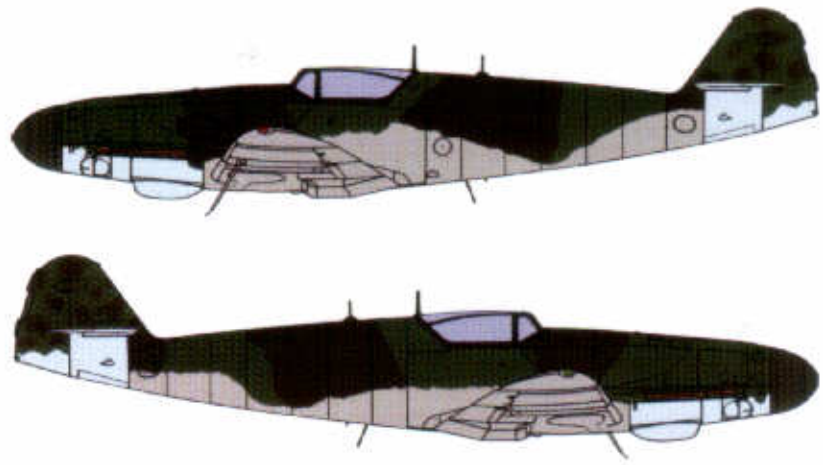


There were numerous variations of pattern, many of which were applied at unit level. The drawings shown here, except where noted, are based on known and verifiable official drawings

1/144 SCALE

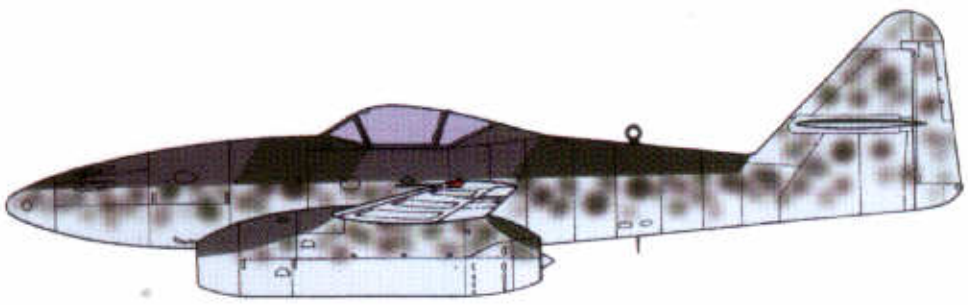
CAMOUFLAGE PATTERNS





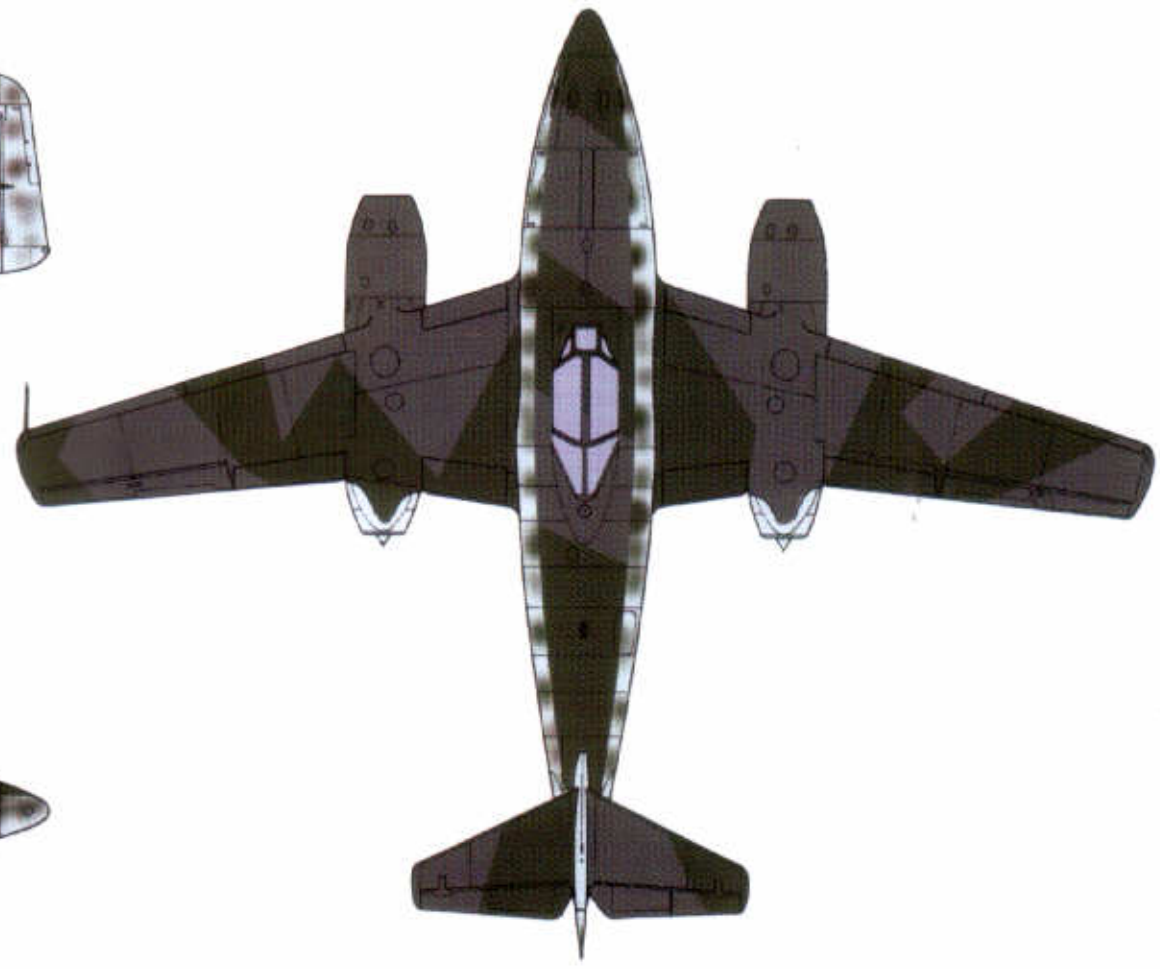
Messerschmitt Bf 109K

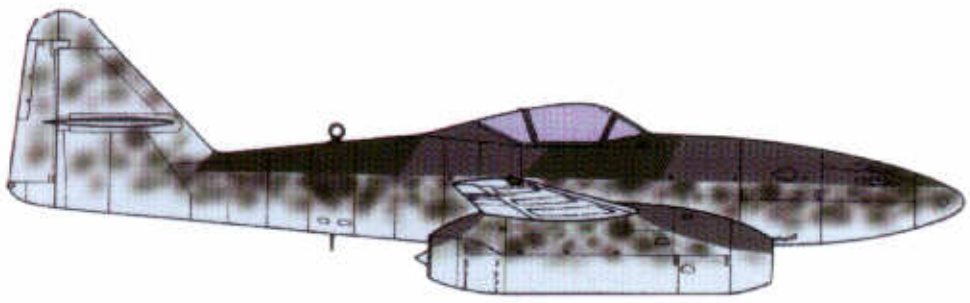
This provisional pattern shows an 81/83 colour combination, with the colour brought well down the fuselage sides. The underside was intended to be only partially painted in 76. Other colours could, and were, substituted. (See page 52) Dispersed production and material shortages meant that there were numerous variations, so it is unrealistic to claim that there was a standard pattern for the late '109s.
Source: Photographs

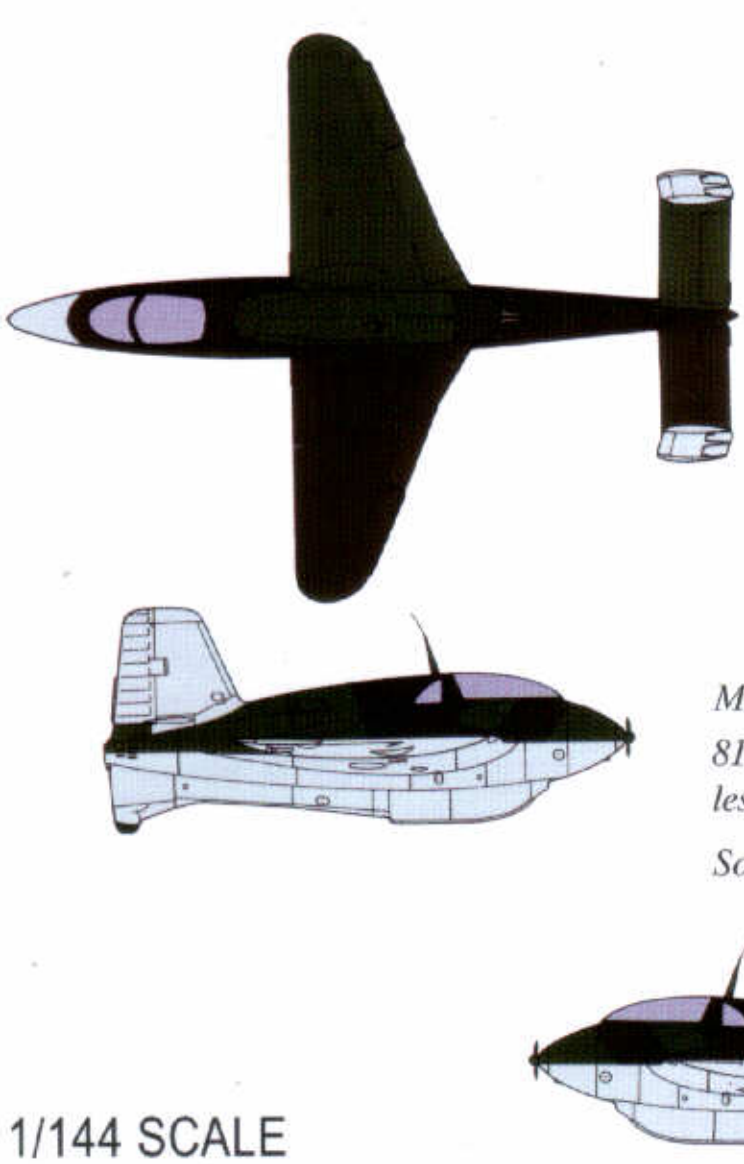


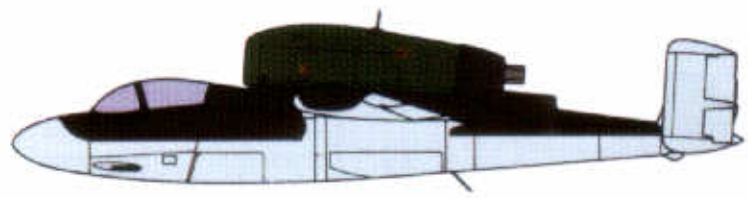
Messerschmitt Me 262. Early production between 17 June-26 November 1944 in 74/75/76. Source: Photographs

Later aircraft were finished in 81/82. See drawing on page 192

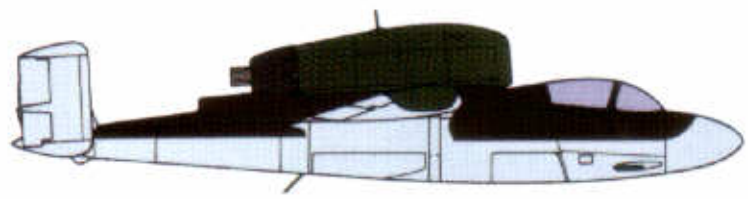




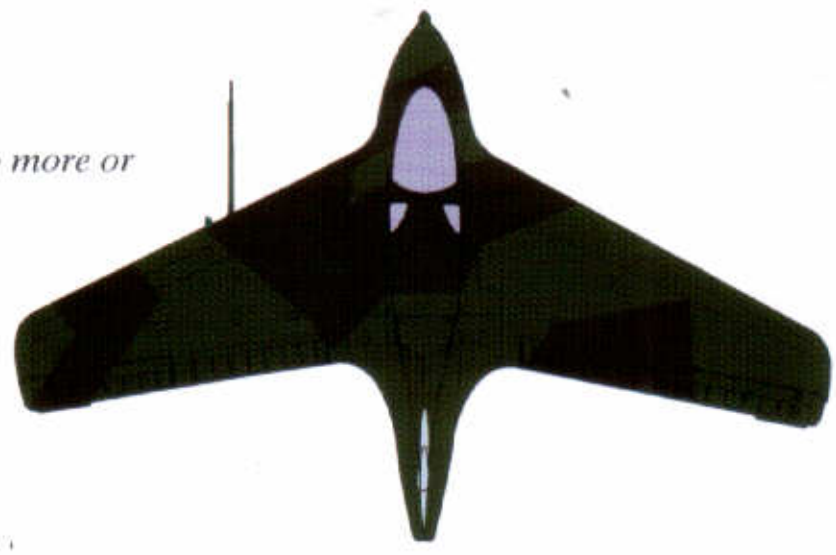


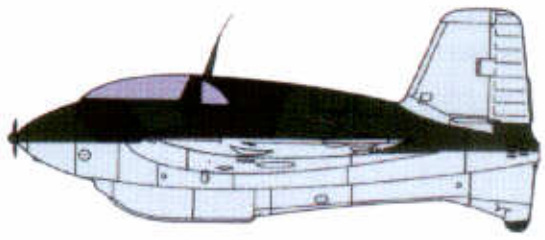


Heinkel He 162
81/82/76
Source: Factory drawings 18 January 1945



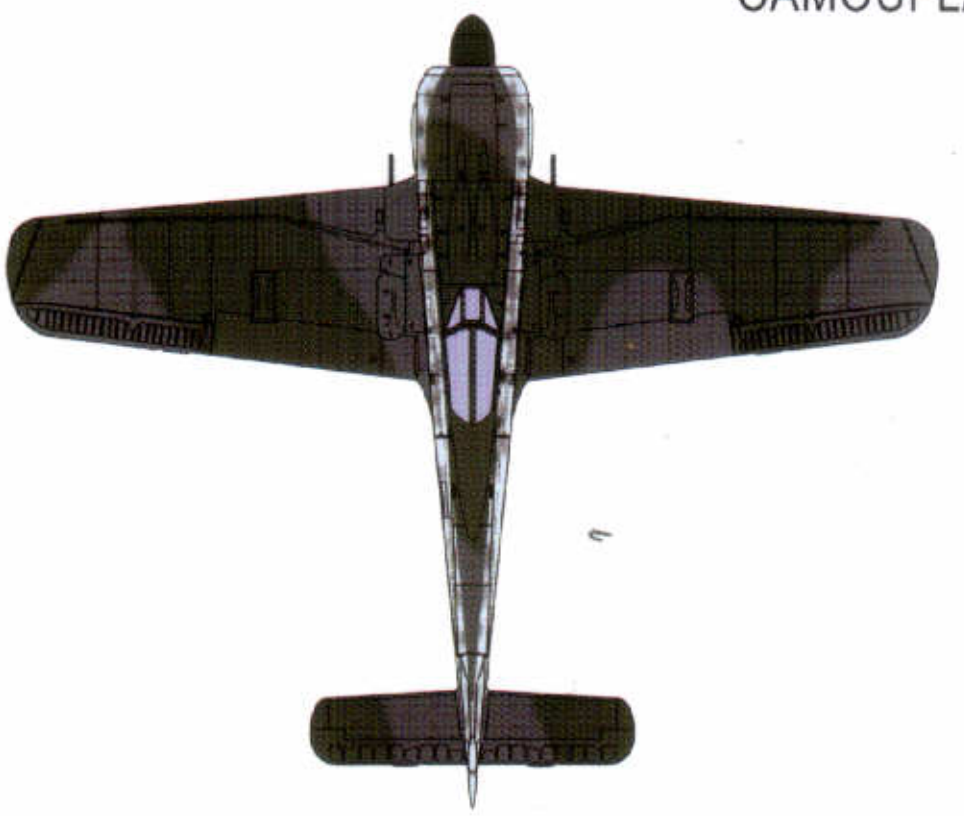
Messerschmitt Me 163B
81/82/76. The fin was subject to more or less mottling
Source: Photographs

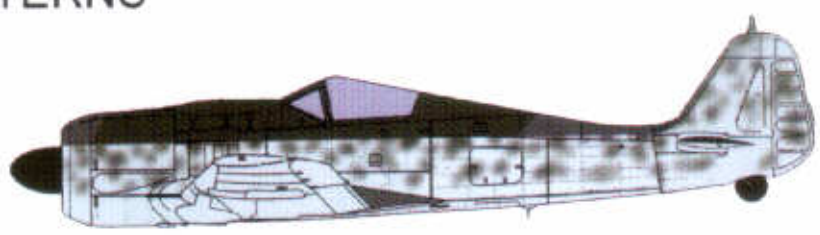




1/144 SCALE

CAMOUFLAGE PATTERNS

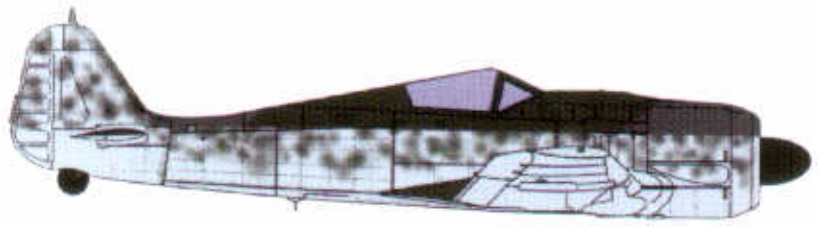


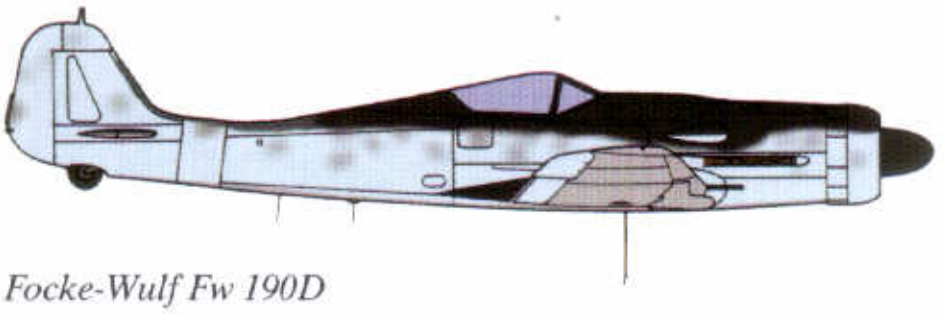


Focke-Wulf Fw 190A

74/75/76. According to RAF reports, very early aircraft may have been finished in 71/02 on upper surfaces

Source: Photographs

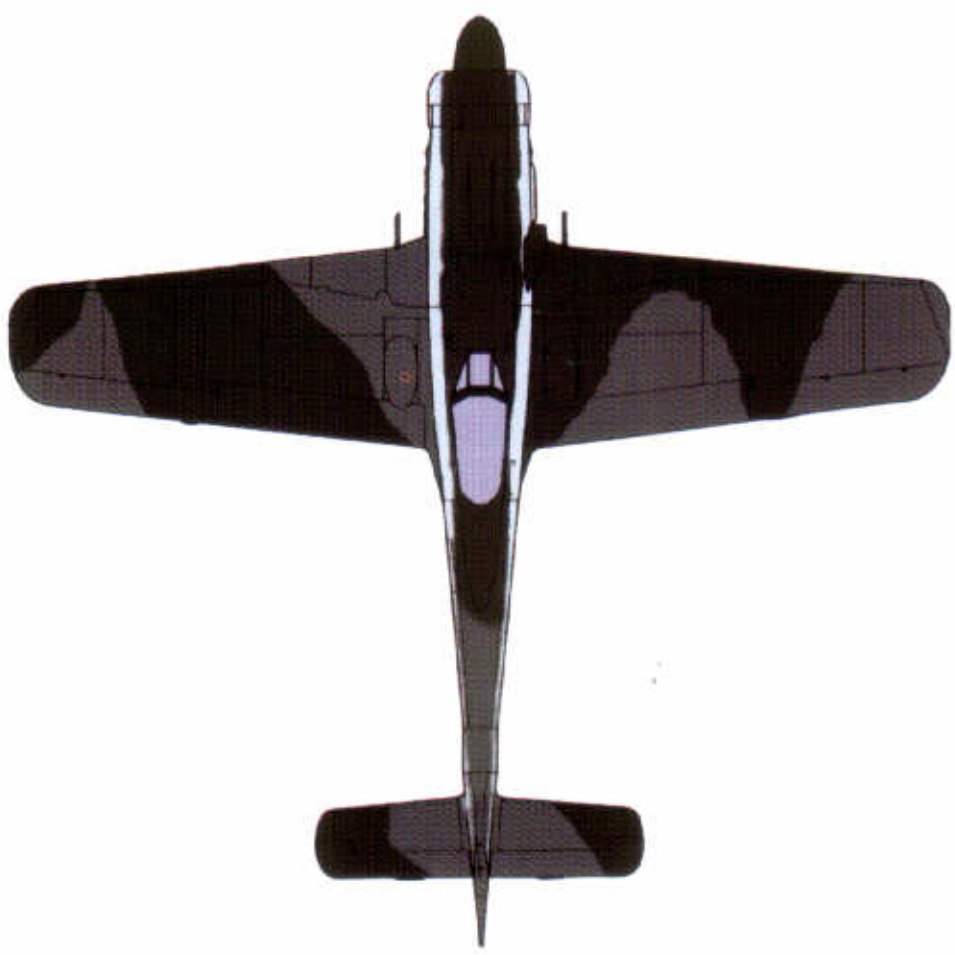


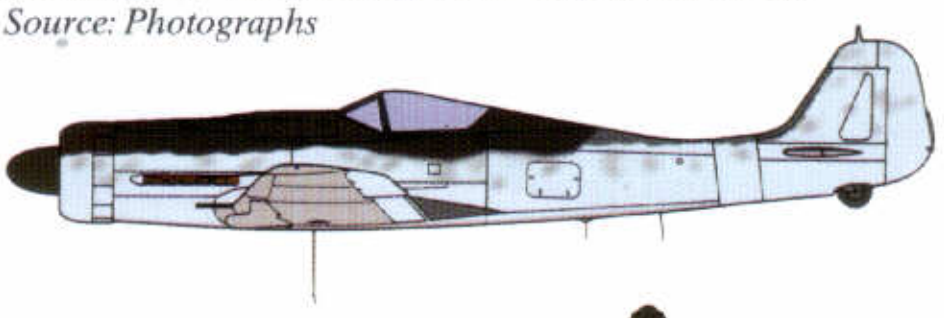


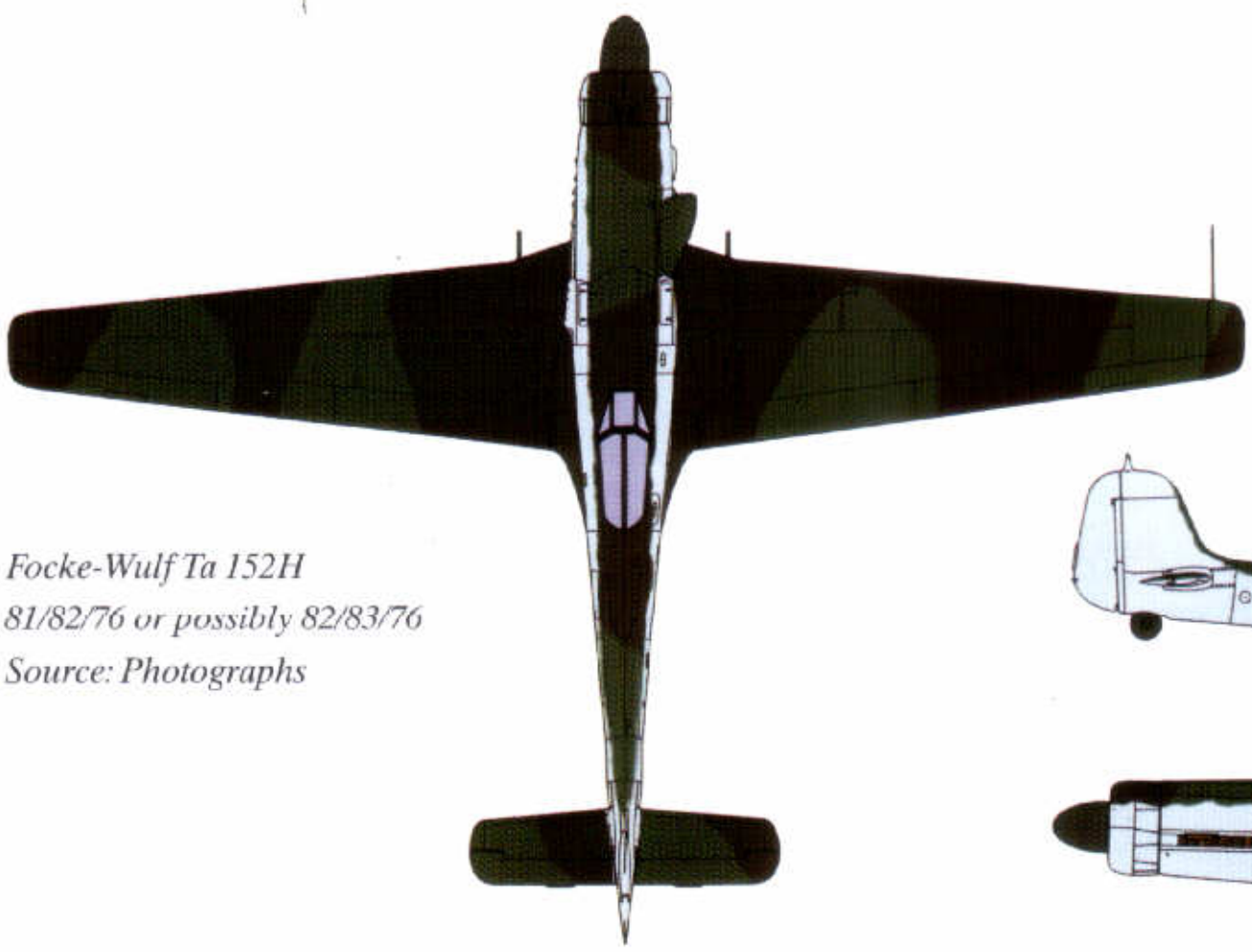
Focke-Wulf Fw 190D

Early production aircraft used 74/75/76, later aircraft used combinations of 75, 81 and 83, with more or less mottling on the fuselage and unpainted areas

Source: Photographs



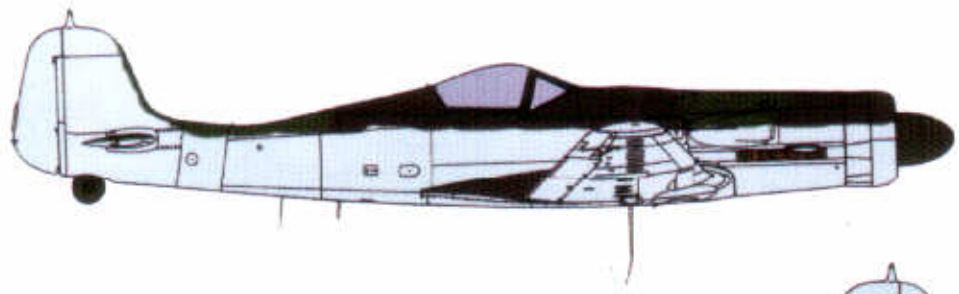


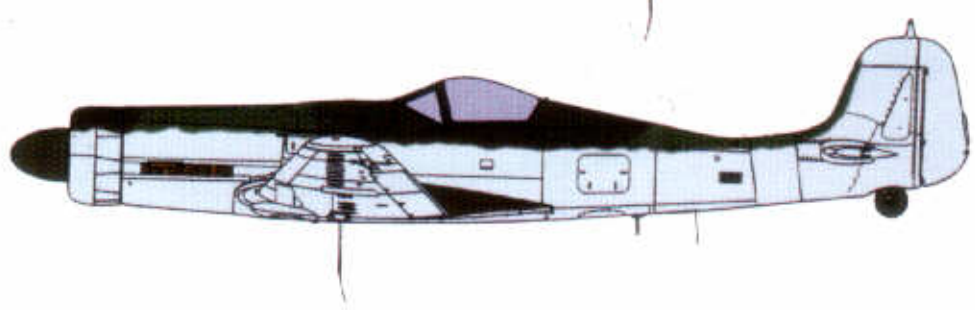


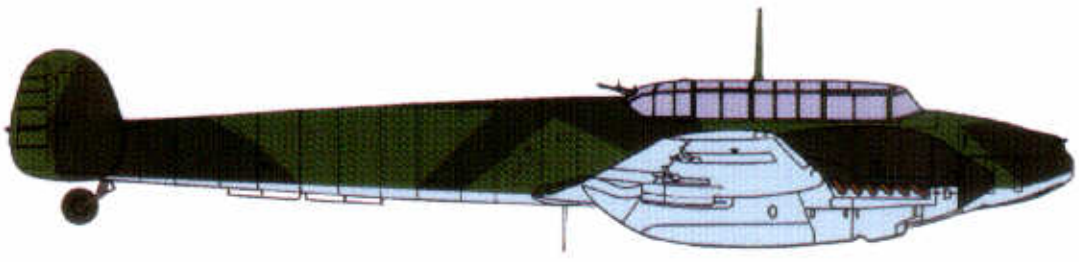
Focke-Wulf Ta 152H

81/82/76 or possibly 82/83/76

Source: Photographs



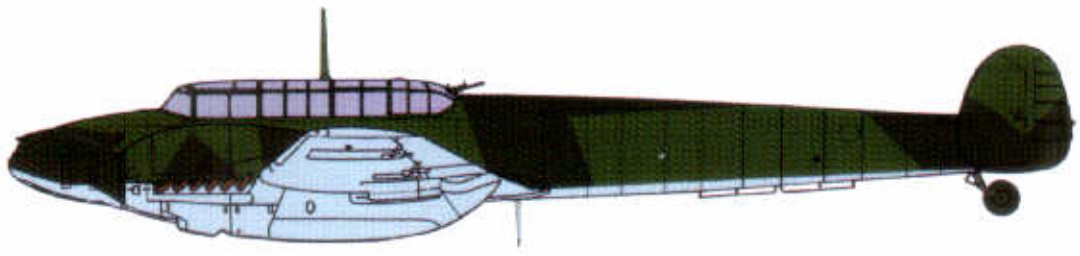




Messerschmitt Bf 110C, 1939-1940

70/71/65

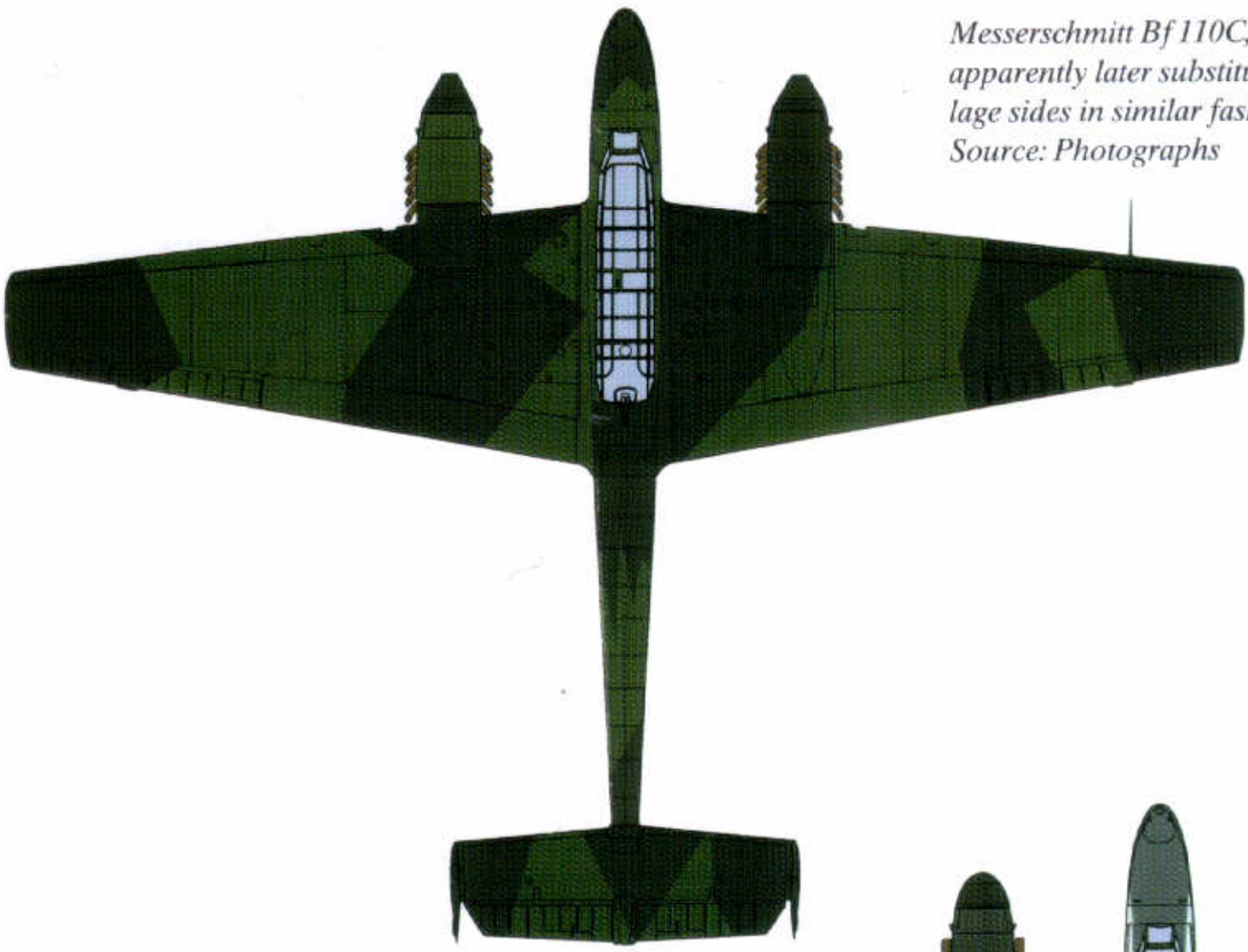
Source: Photographs



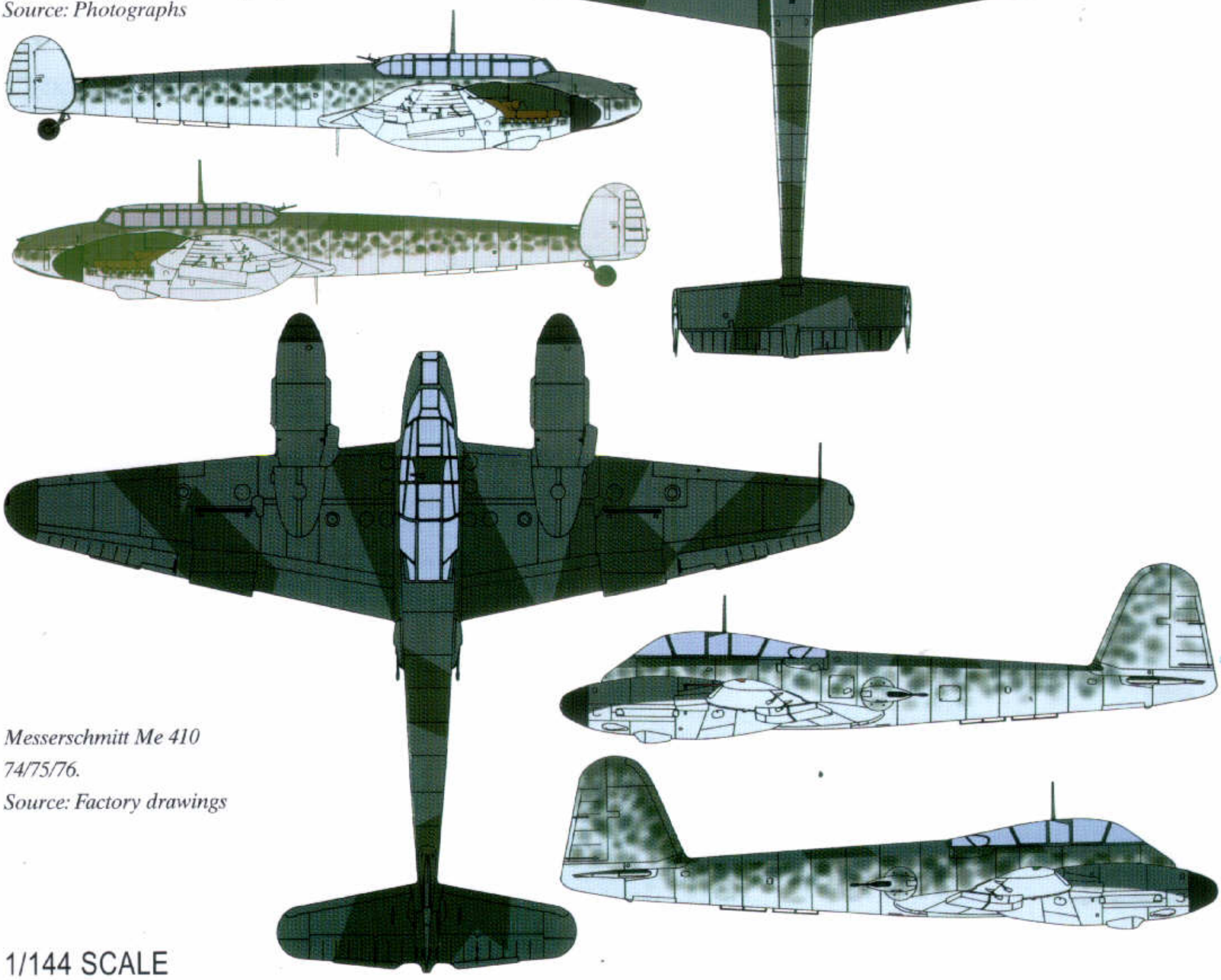
1/144 SCALE

CAMOUFLAGE PATTERNS

Messerschmitt Bf 110C, 1939-early 1940. 70/71/65. Aircraft apparently later substituted 02 for 70 and mottled the fuselage sides in similar fashion to Bf 109s of the period
Source: Photographs



Messerschmitt Bf 110F and G
74/75/76. This scheme was often greatly modified by mottling. Night fighters were usually mottled all over on uppersides or given a solid coat of 75 on wings and fuselage spine
Source: Photographs

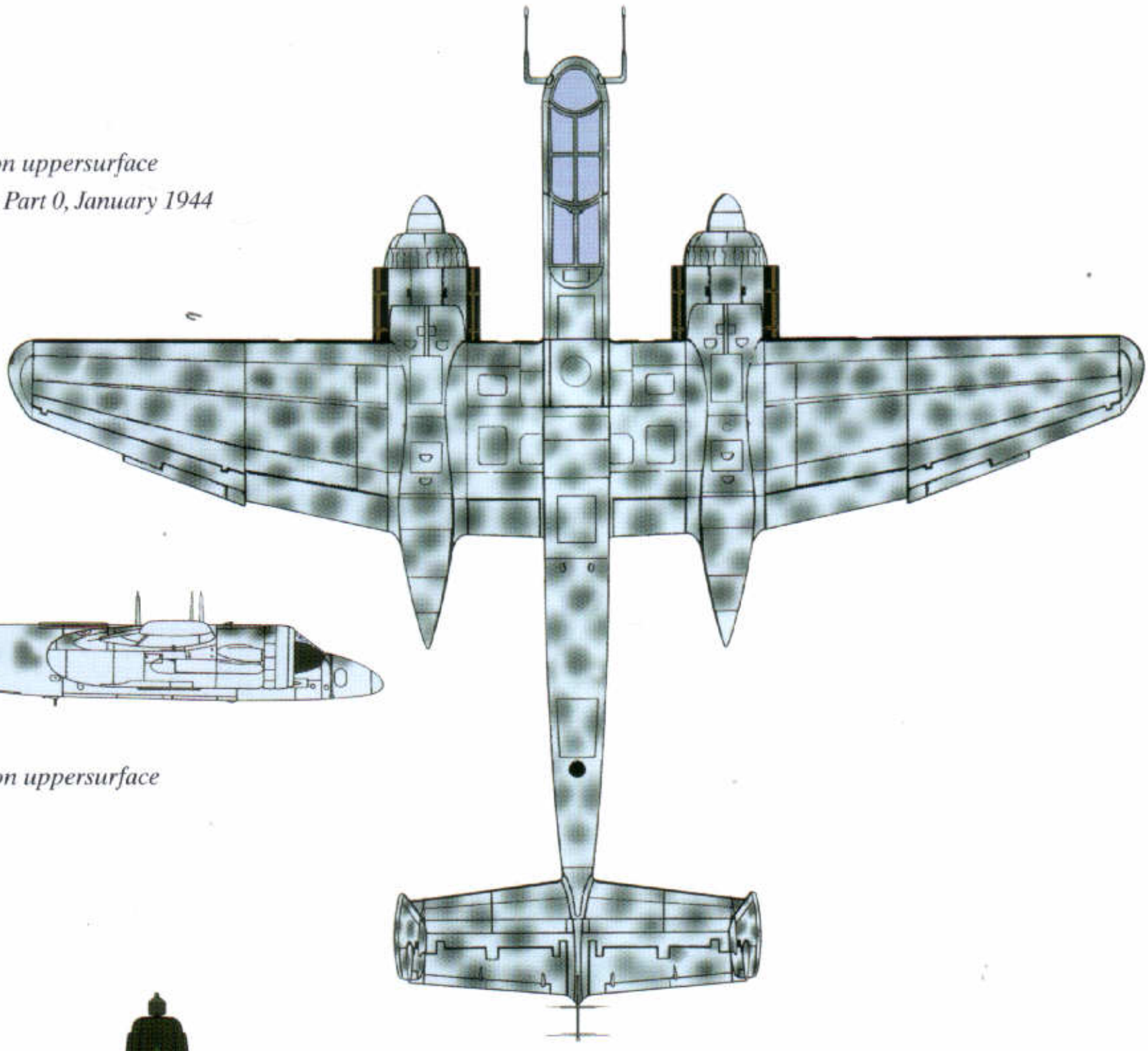


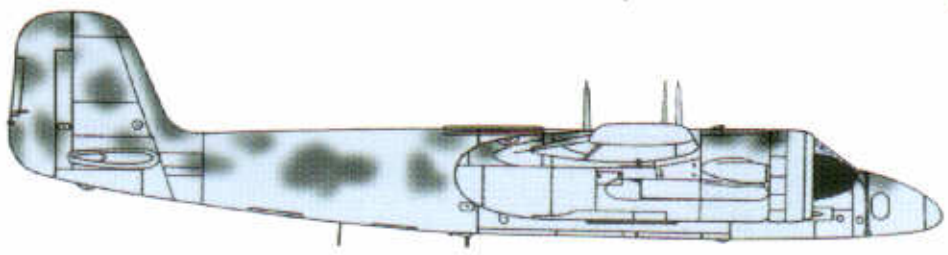
Messerschmitt Me 410
74/75/76.
Source: Factory drawings

1/144 SCALE

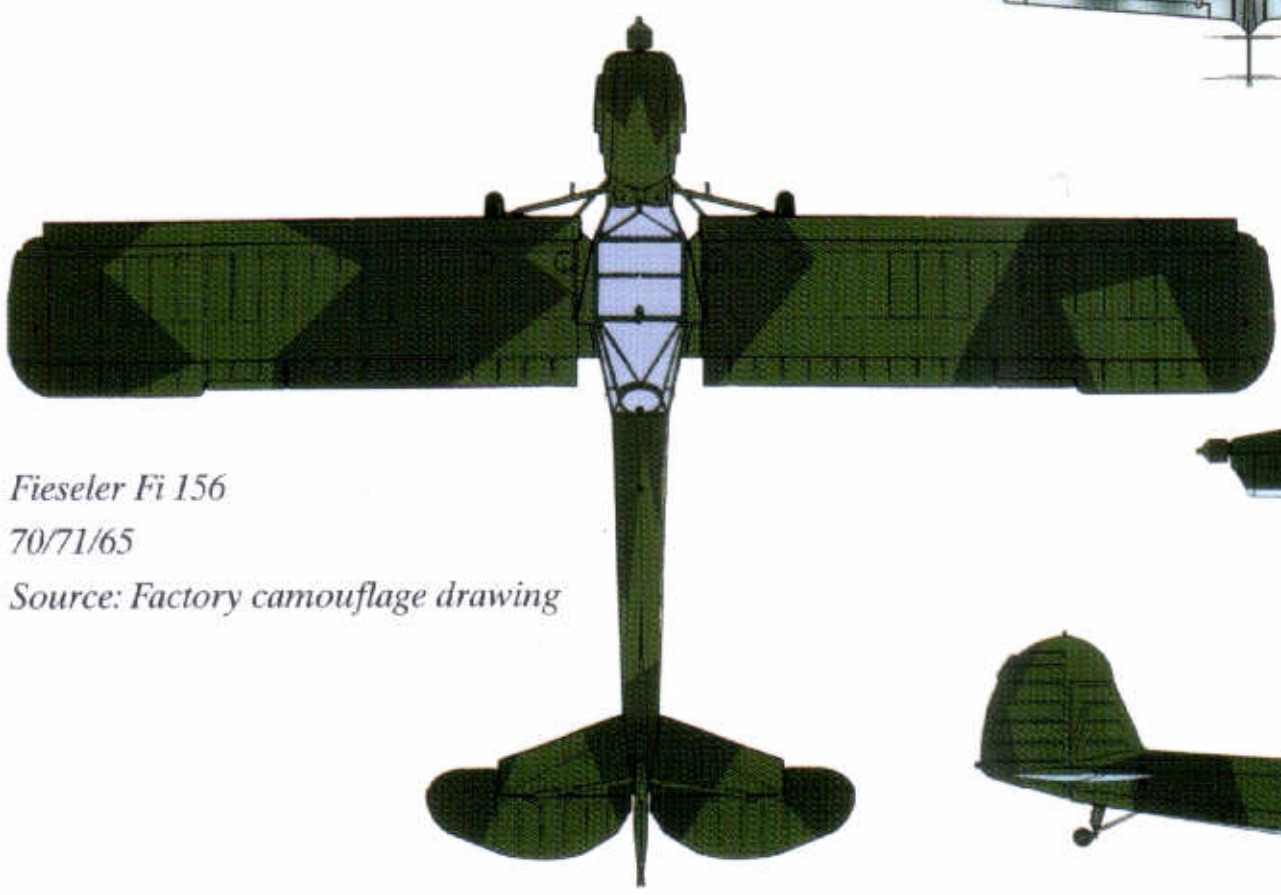
CAMOUFLAGE PATTERNS

Heinkel He 219
76 overall with 75 mottles on uppersurface
Source: Aircraft handbook Part 0, January 1944

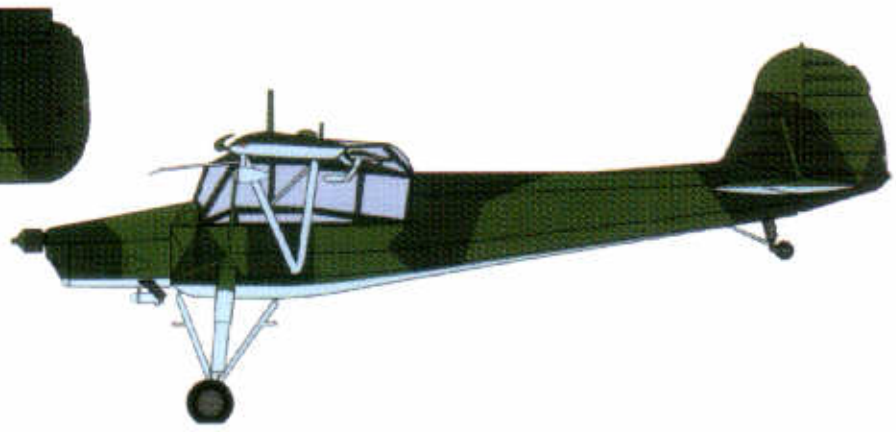


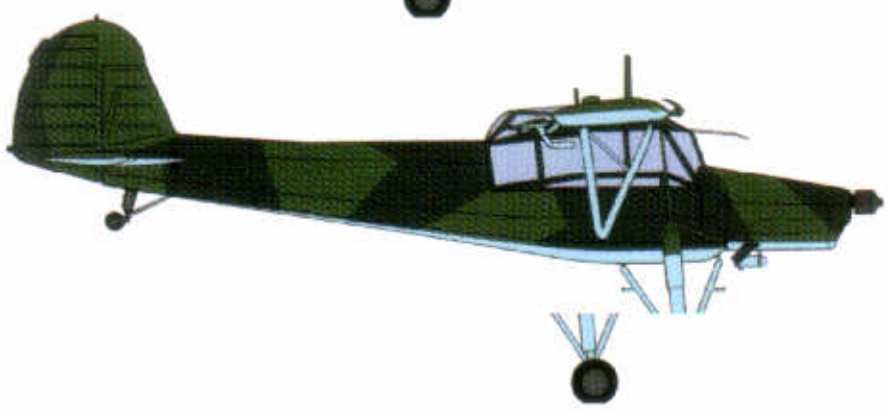


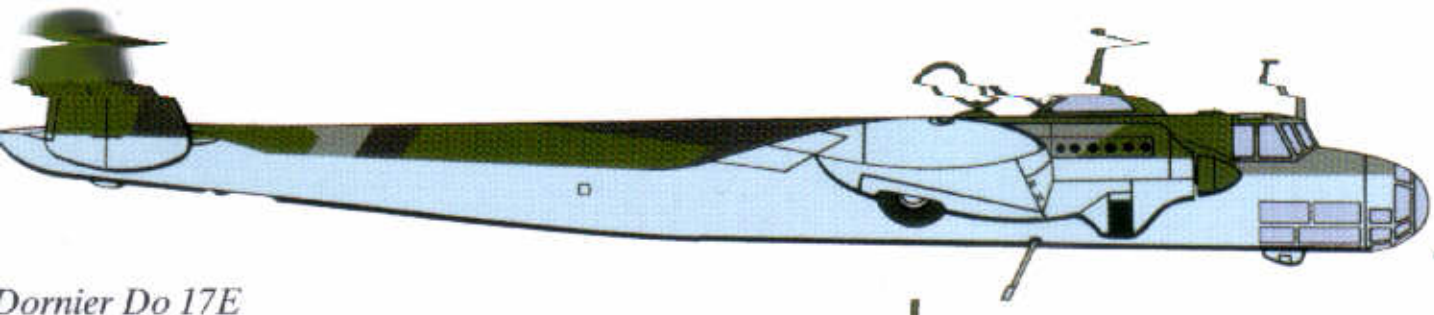
Focke-Wulf Ta 154
76 overall with 75 mottles on uppersurface
Source: Photographs



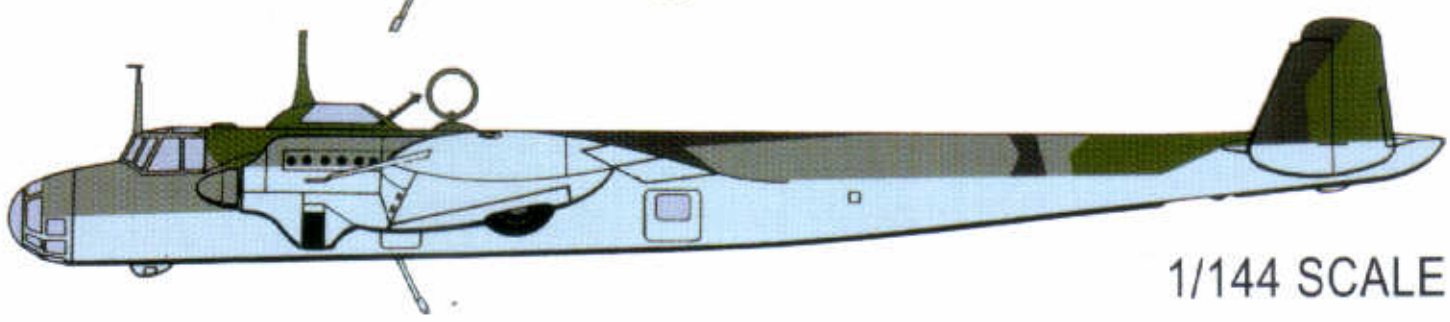
Fieseler Fi 156
70/71/65
Source: Factory camouflage drawing







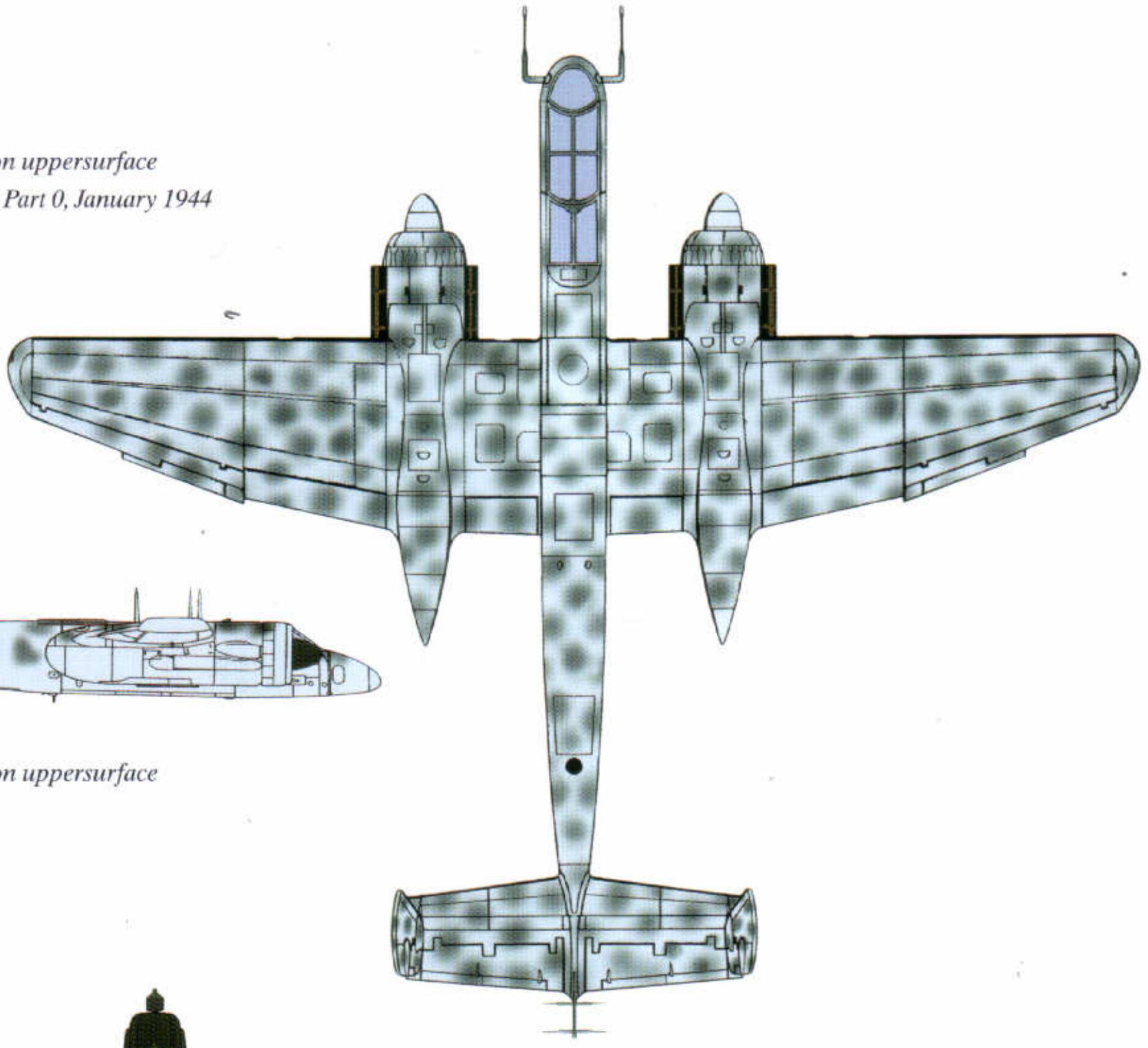
Dornier Do 17E
61/62/63/65
Starboard side Pattern A (above)
Port side Pattern B (right)
Source: Factory drawings
(See pages 48-49)

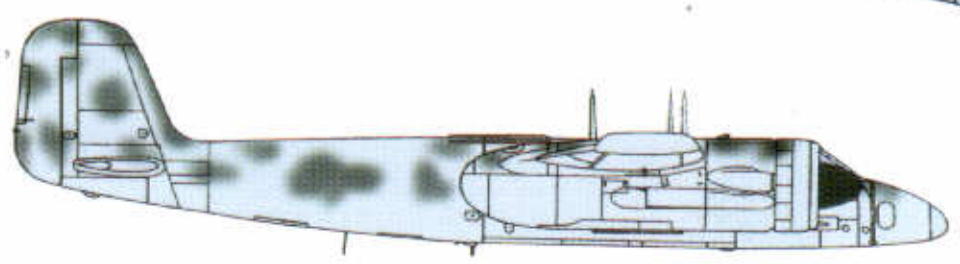


1/144 SCALE

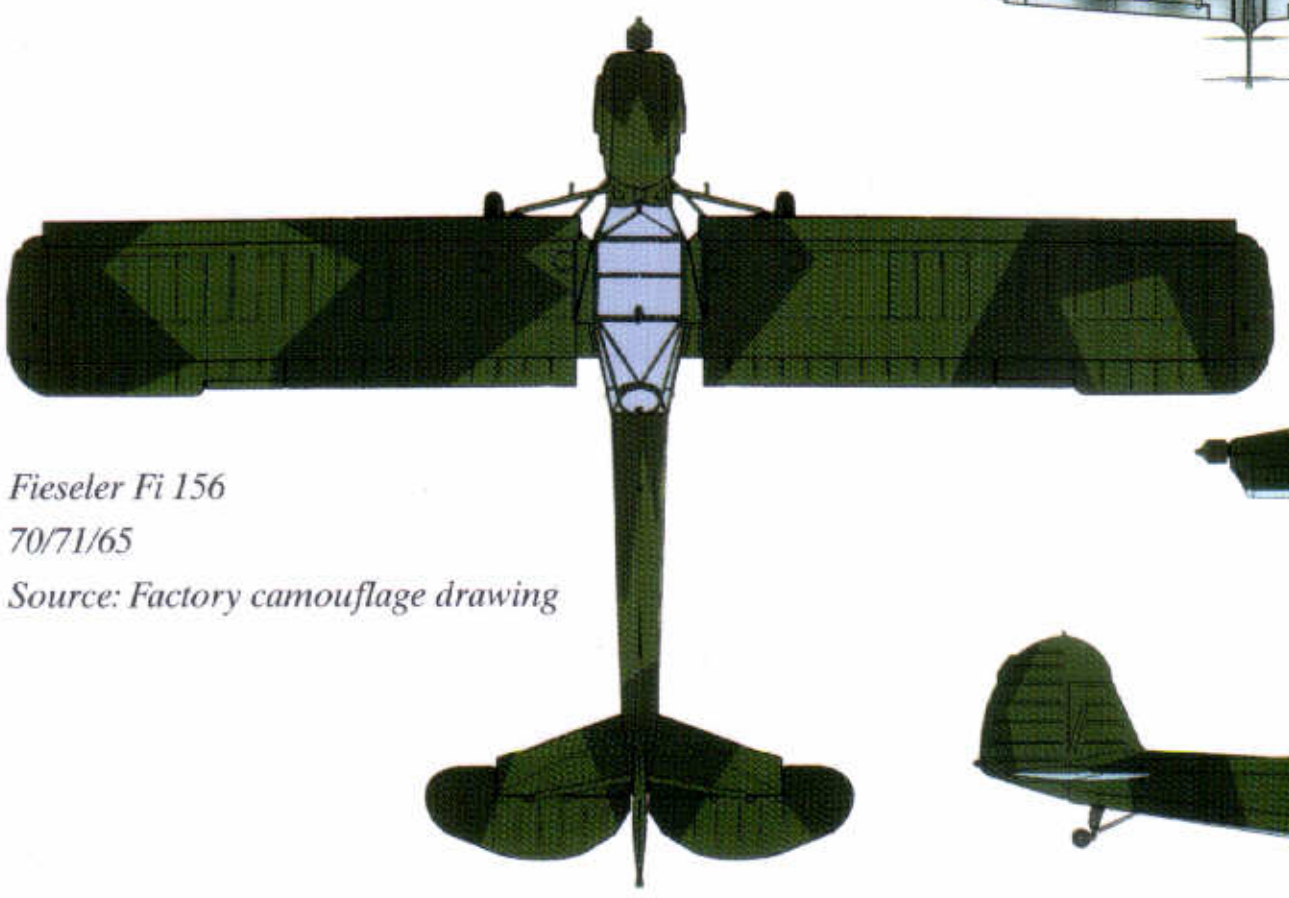
CAMOUFLAGE PATTERNS

Heinkel He 219
76 overall with 75 mottles on uppersurface
Source: Aircraft handbook Part 0, January 1944

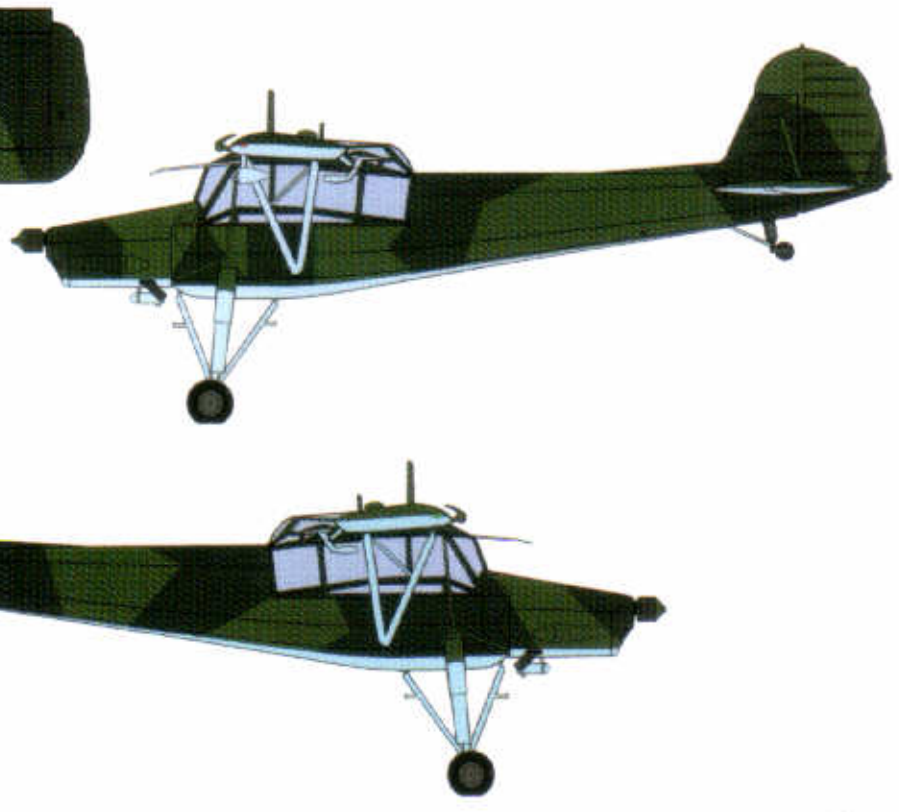


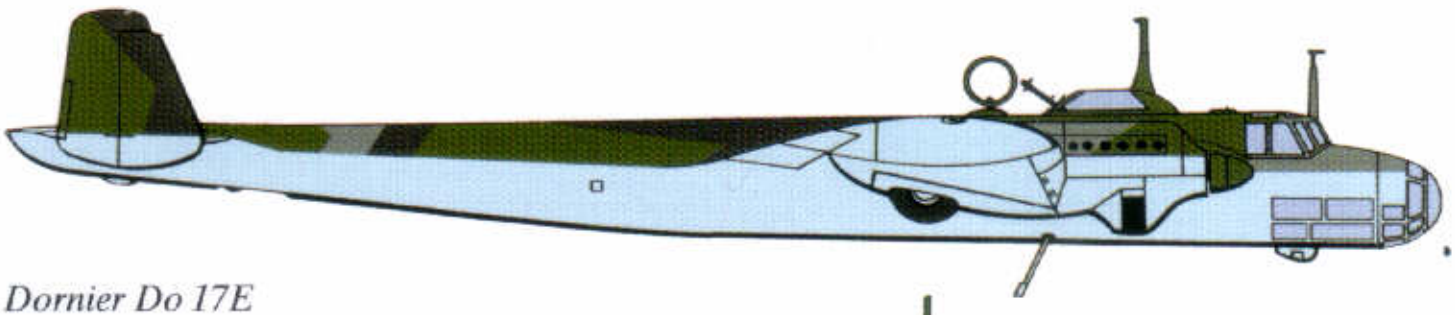


Focke-Wulf Ta 154
76 overall with 75 mottles on uppersurface
Source: Photographs

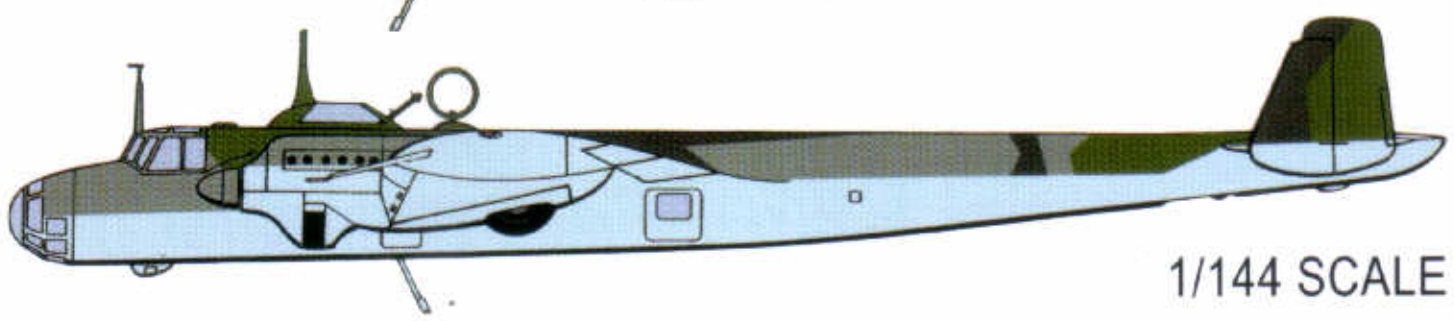


Fieseler Fi 156
70/71/65
Source: Factory camouflage drawing





Dornier Do 17E
61/62/63/65
Starboard side Pattern A (above)
Port side Pattern B (right)
Source: Factory drawings
(See pages 48-49)



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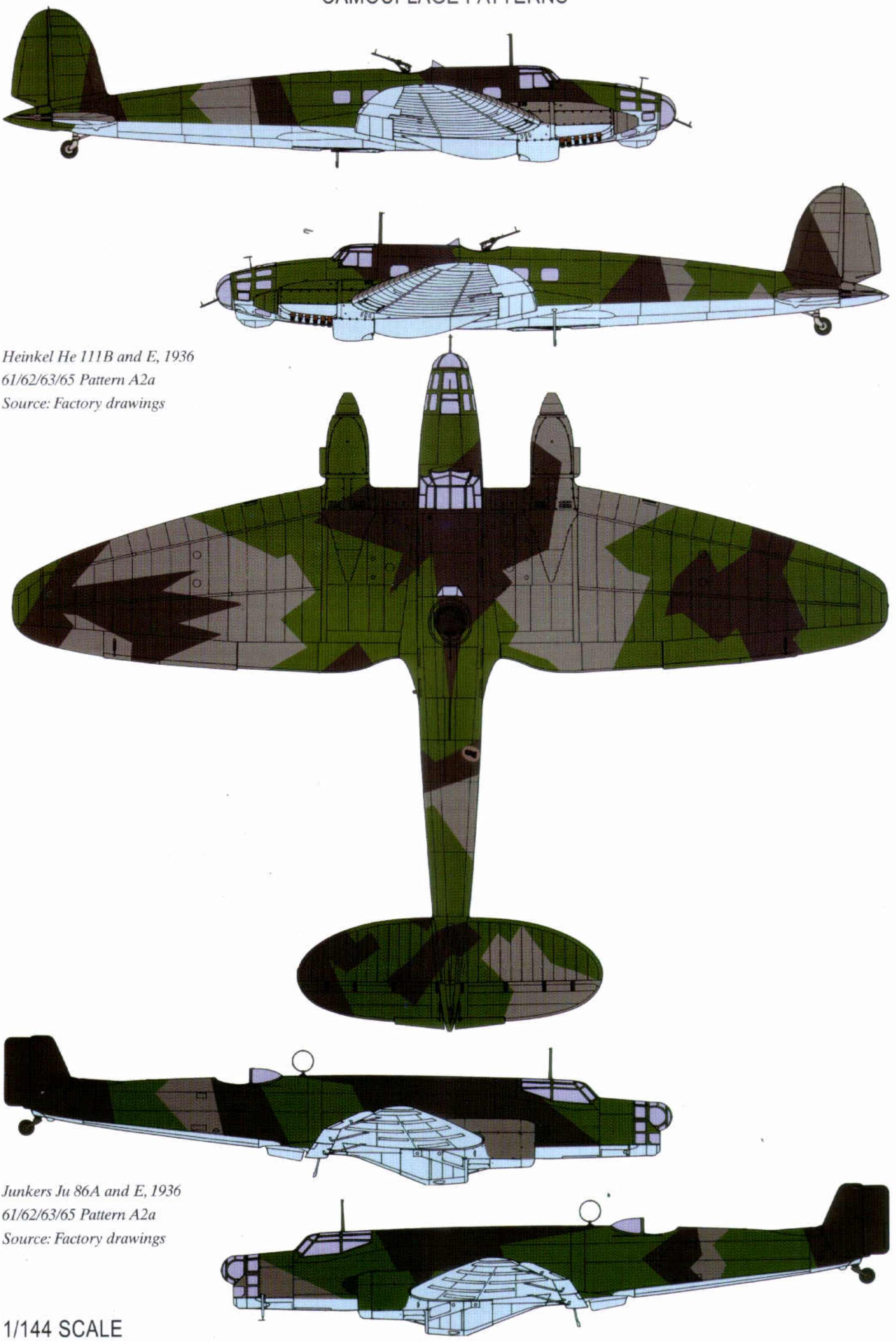
CAMOUFLAGE PATTERNS



Heinkel He 111B and E, 1936
61/62/63/65 Pattern A2a
Source: Factory drawings

Junkers Ju 86A and E, 1936
61/62/63/65 Pattern A2a
Source: Factory drawings

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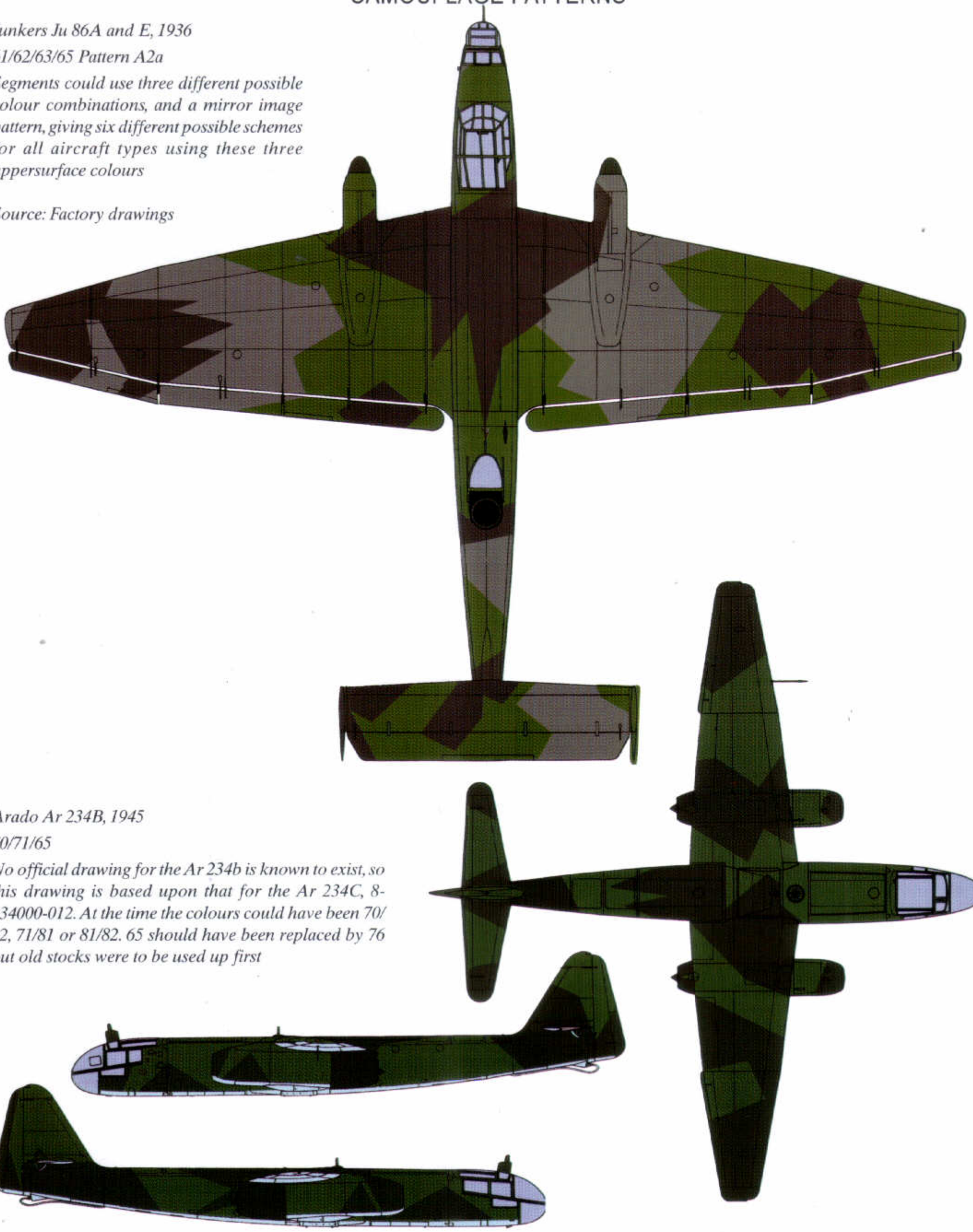
CAMOUFLAGE PATTERNS

Junkers Ju 86A and E, 1936

61/62/63/65 Pattern A2a

Segments could use three different possible colour combinations, and a mirror image pattern, giving six different possible schemes for all aircraft types using these three uppersurface colours

Source: Factory drawings



Arado Ar 234B, 1945

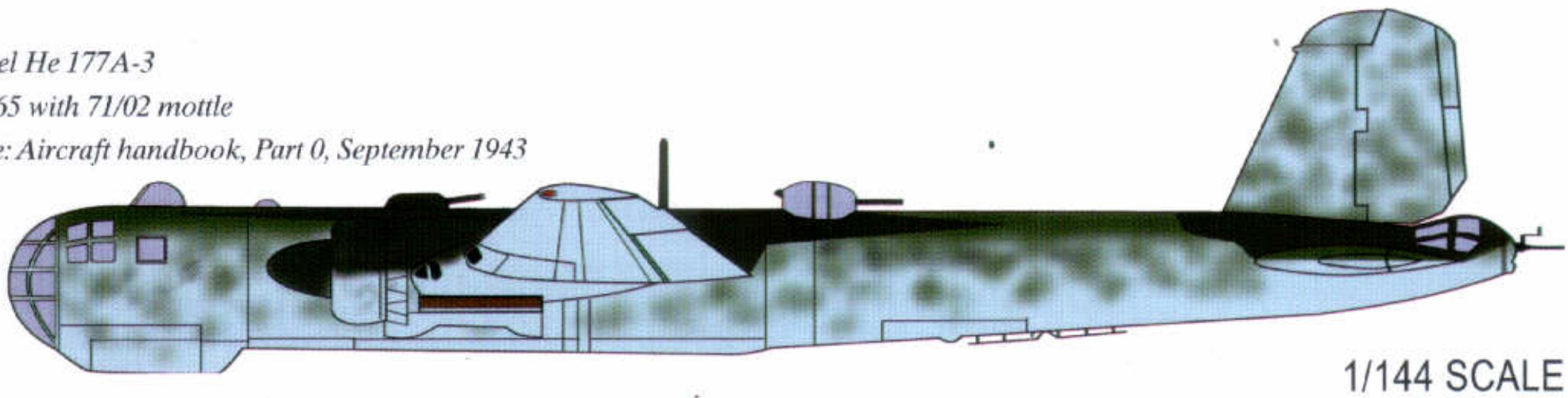
70/71/65

No official drawing for the Ar 234b is known to exist, so this drawing is based upon that for the Ar 234C, 8-234000-012. At the time the colours could have been 70/82, 71/81 or 81/82. 65 should have been replaced by 76 but old stocks were to be used up first

Heinkel He 177A-3

70/71/65 with 71/02 mottle

Source: Aircraft handbook, Part 0, September 1943



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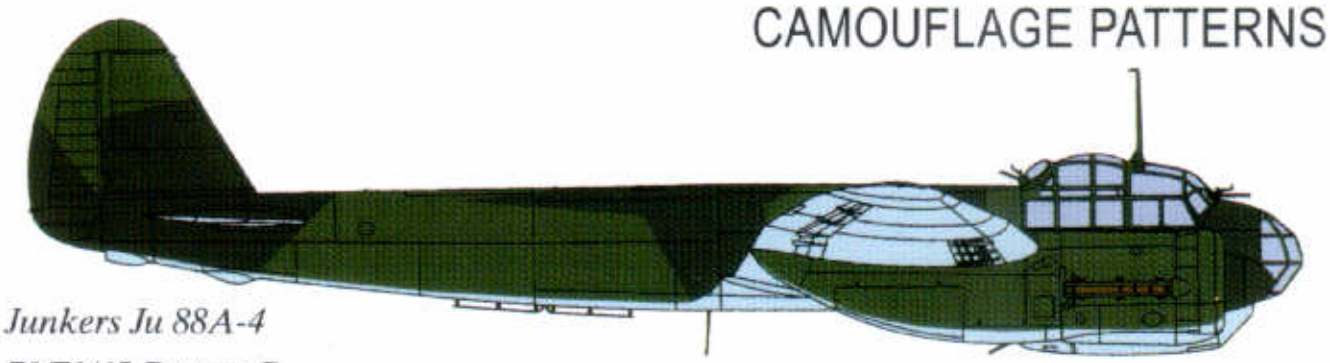
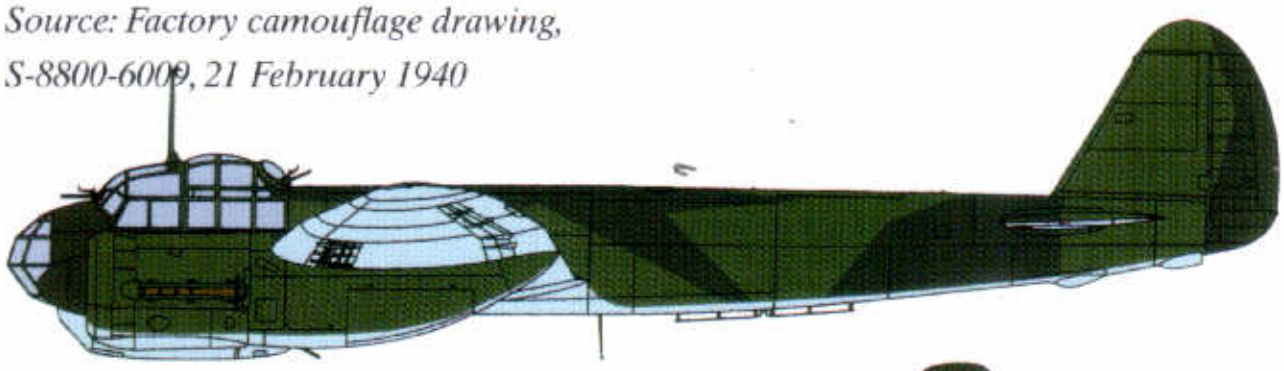
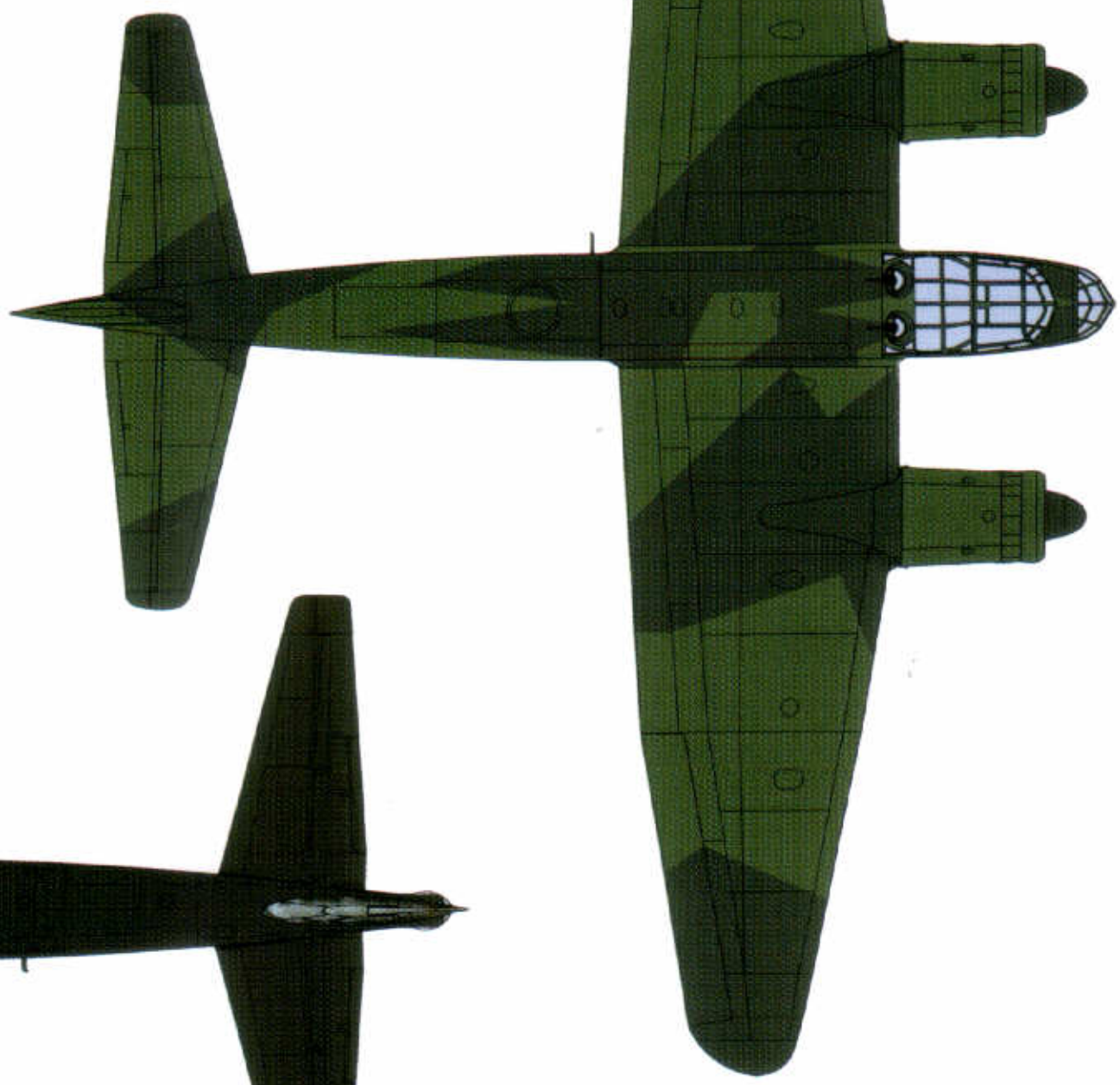
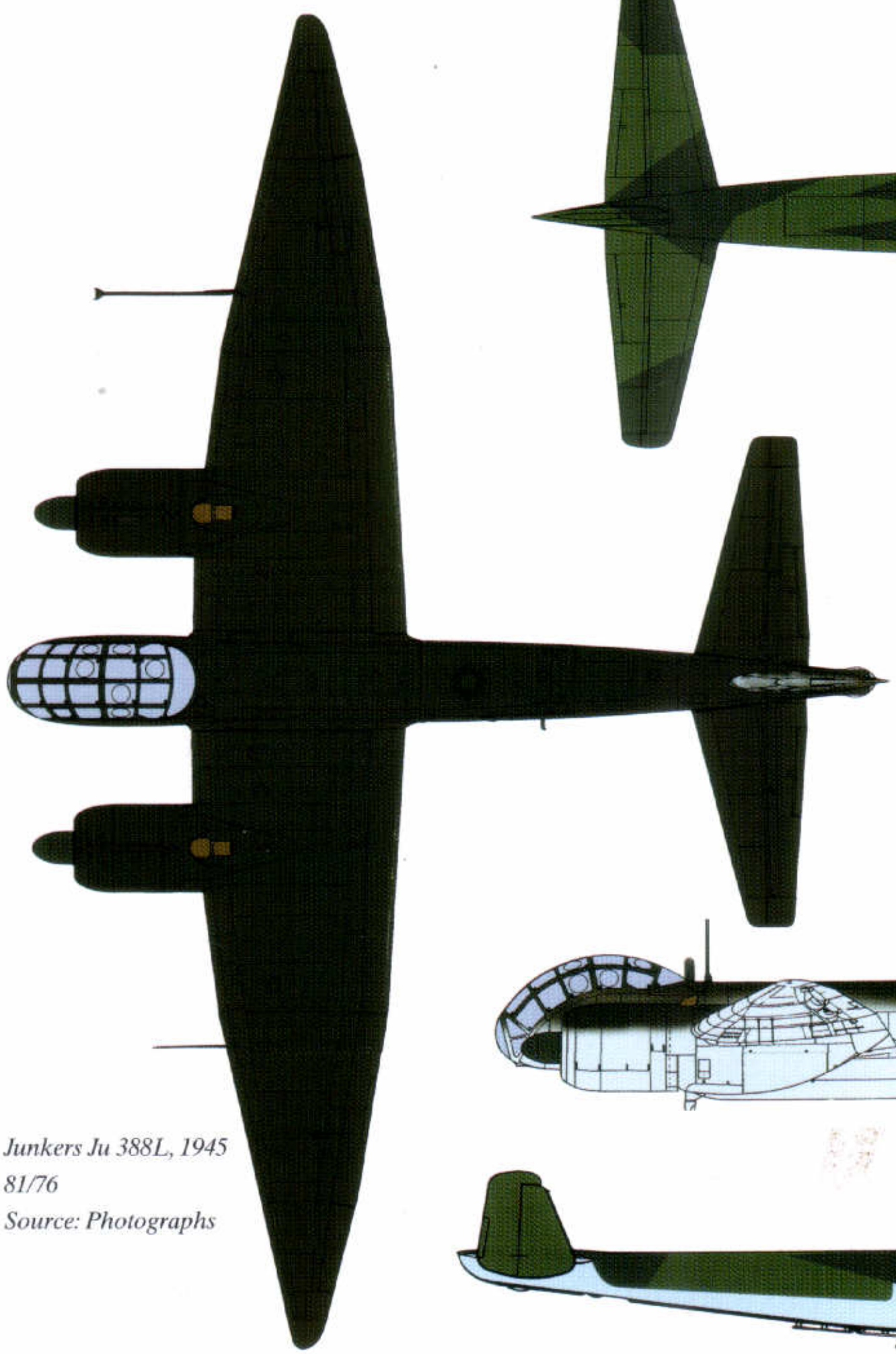
CAMOUFLAGE PATTERNS



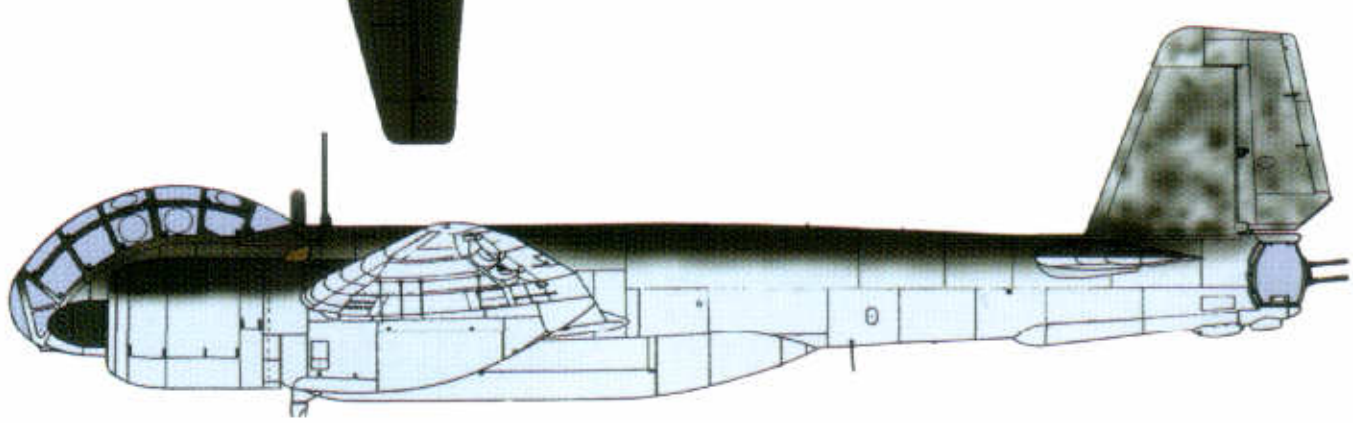
Junkers Ju 88A-4
70/71/65 Pattern B
Source: Factory camouflage drawing,
S-8800-6009, 21 February 1940

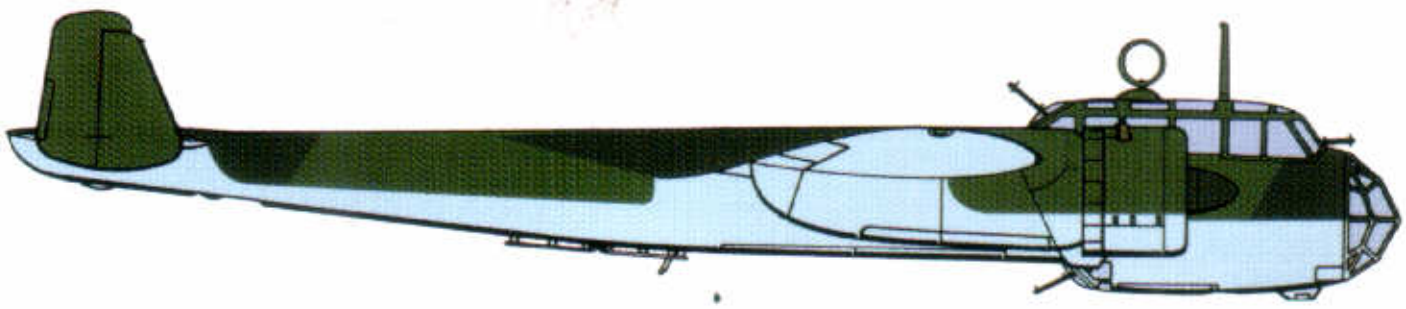




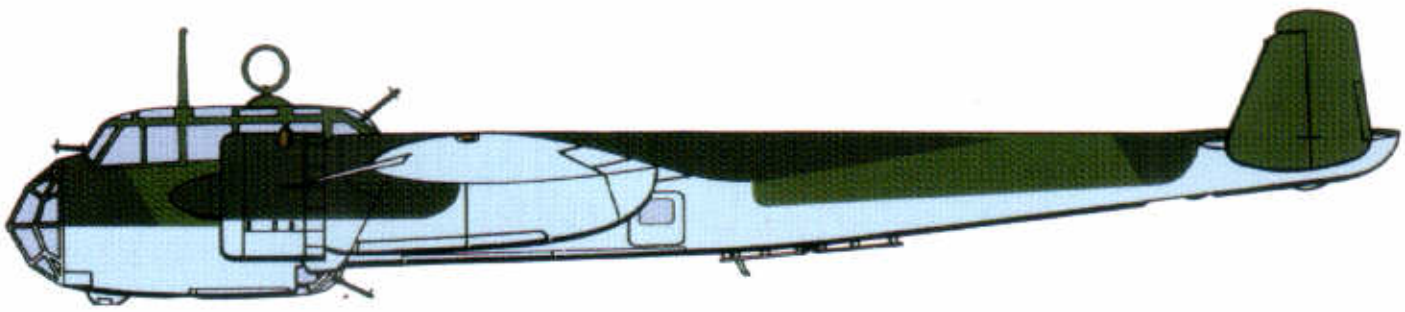


Junkers Ju 388L, 1945
81/76
Source: Photographs





Dornier Do 17Z, 1940
70/71/65
Source: Factory camouflage drawing



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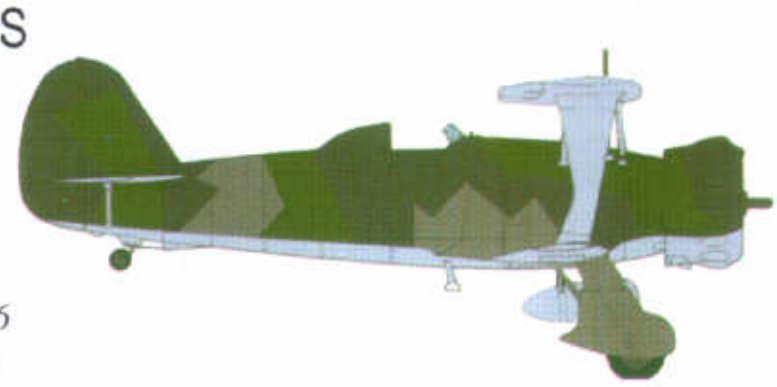
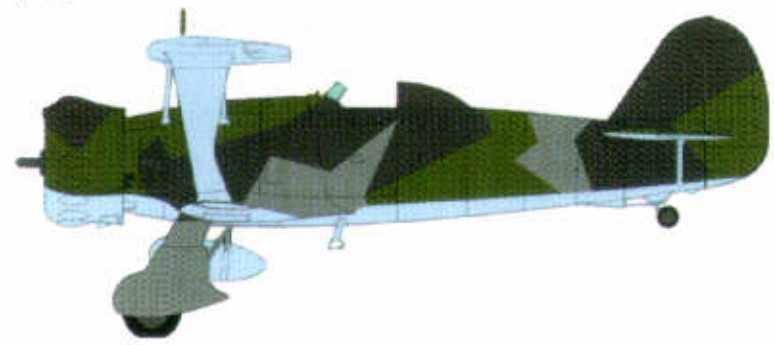
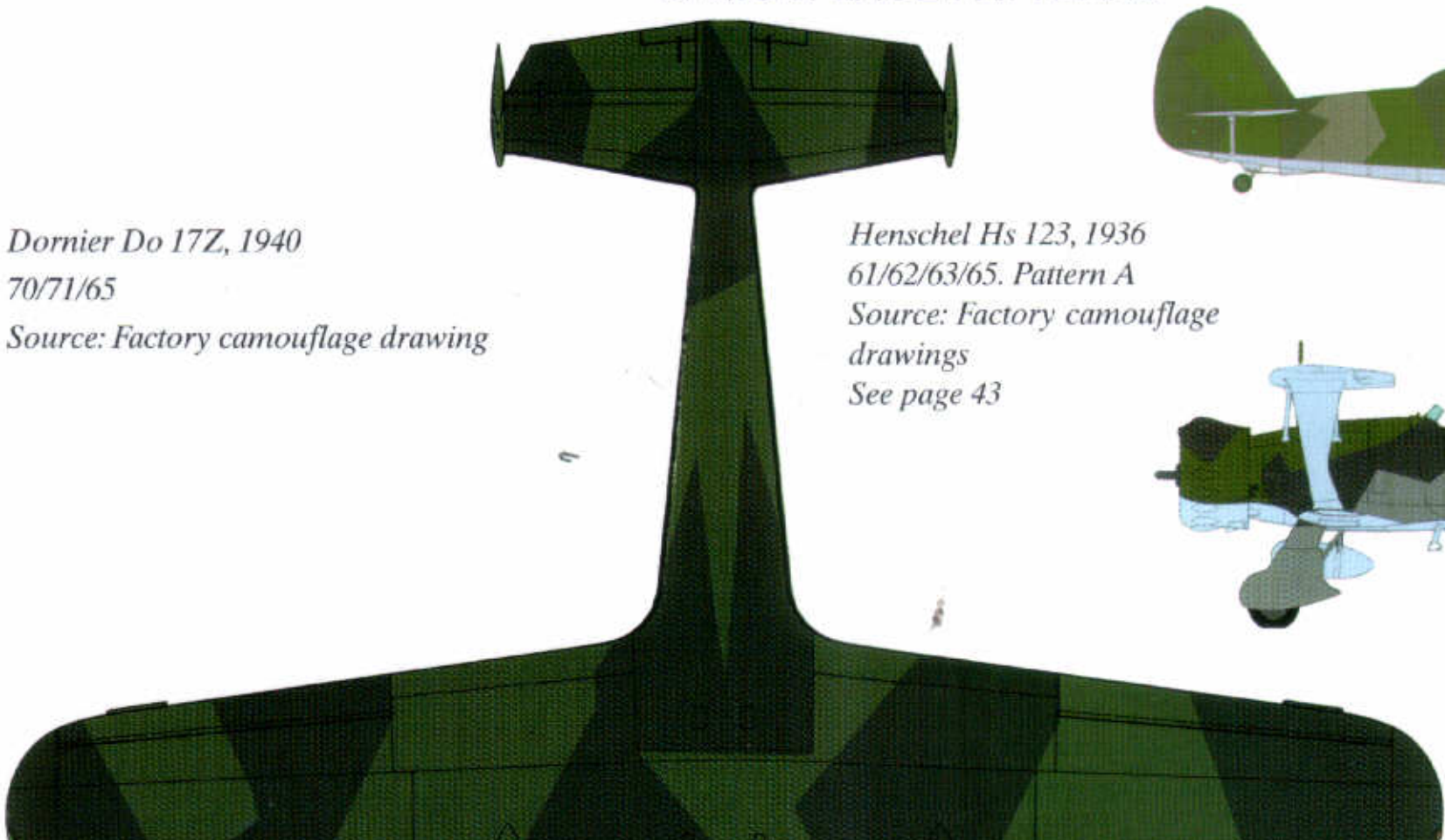
CAMOUFLAGE PATTERNS



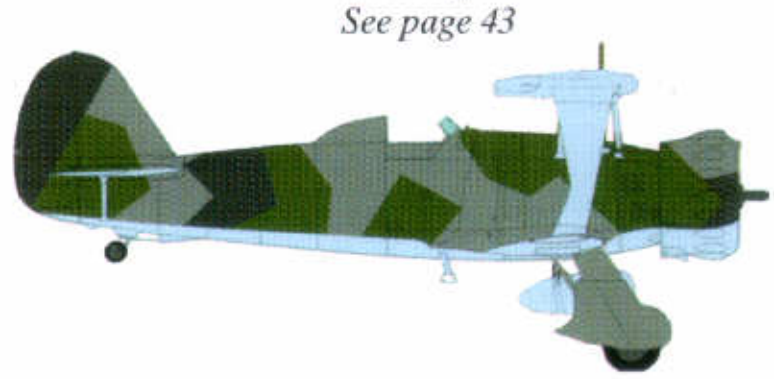
Henschel Hs 123, 1936
61/62/63/65. Pattern A
Source: Factory camouflage drawings
See page 43



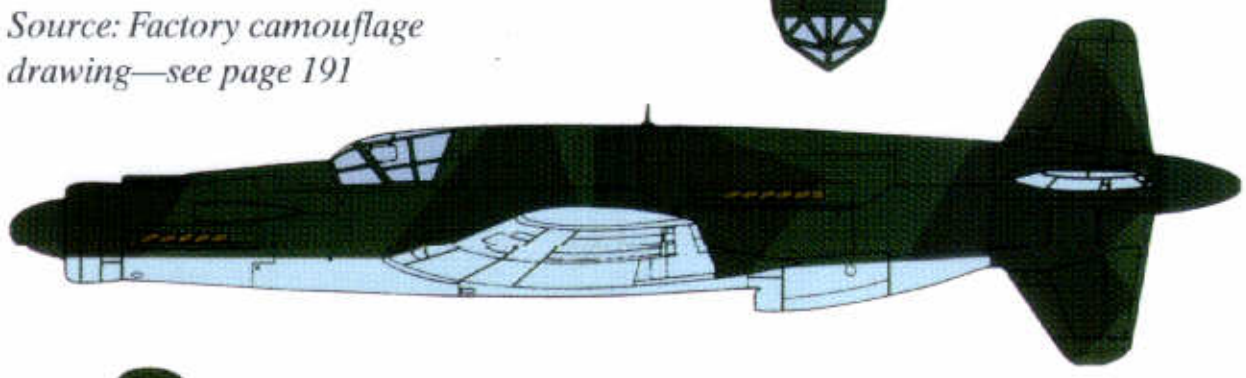
Dornier Do 17Z, 1940
70/71/65
Source: Factory camouflage drawing

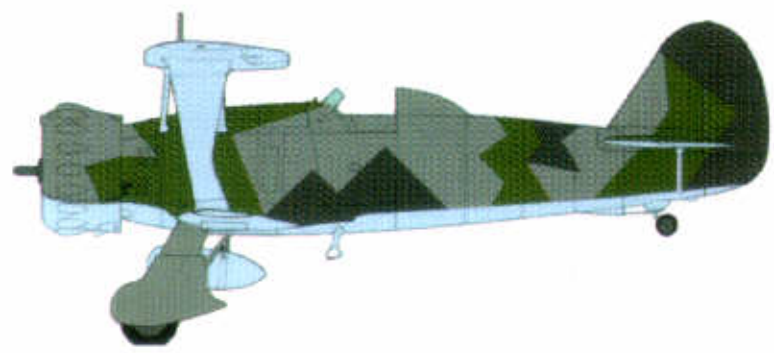


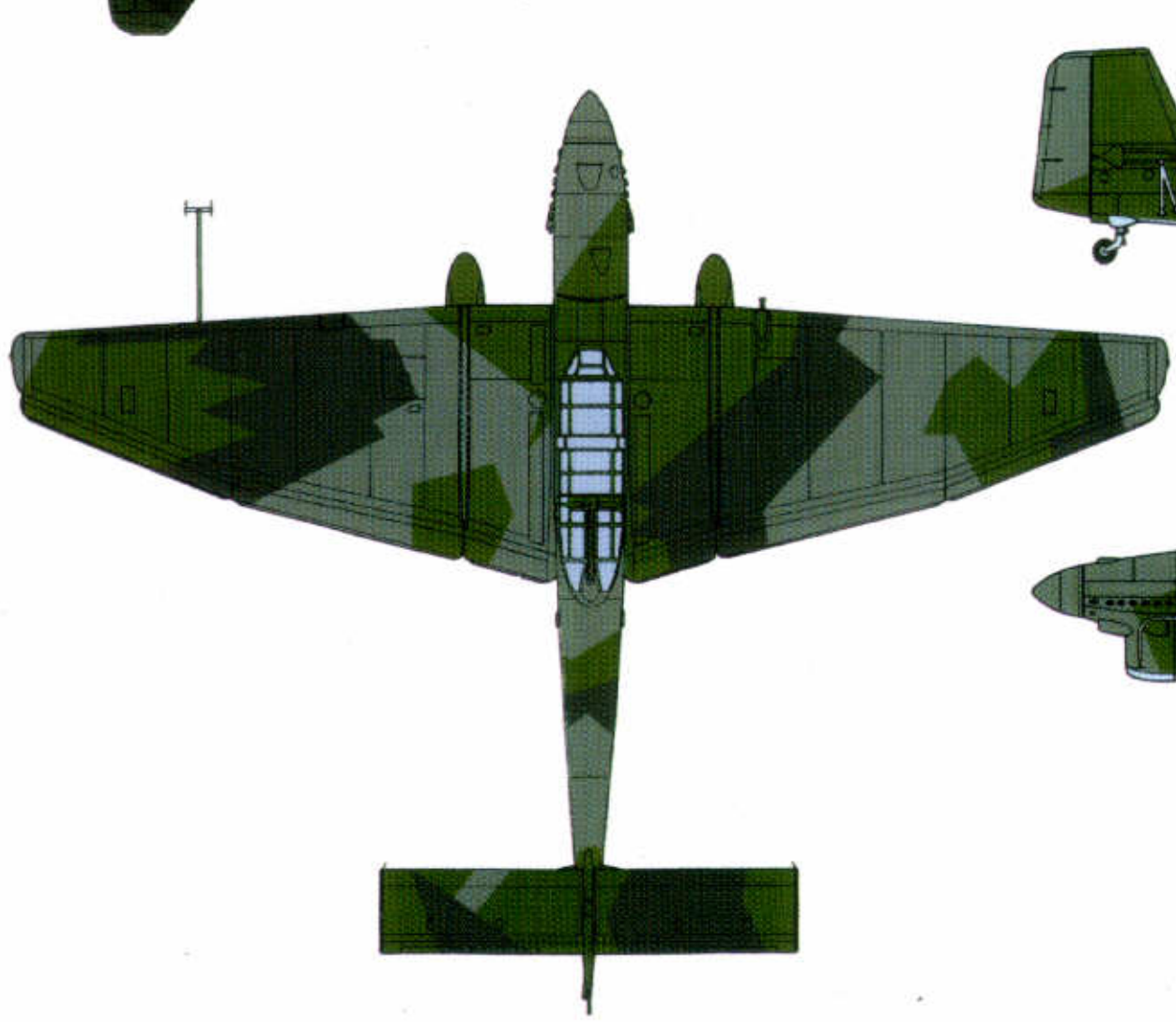
Henschel Hs 123, 1936
61/62/63/65. Pattern B
Source: Factory camouflage drawings
See page 43

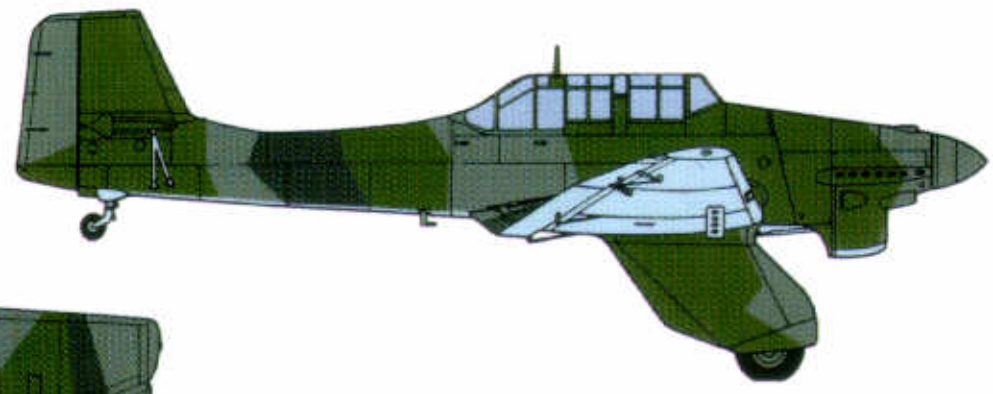


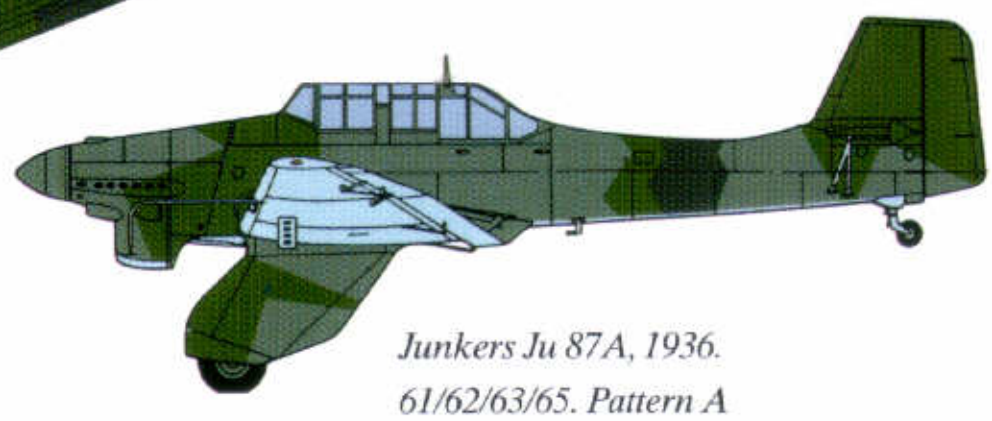
Dornier Do 335, 1945
81/82/65
Source: Factory camouflage drawing—see page 191











Junkers Ju 87A, 1936.
61/62/63/65. Pattern A
Source: Factory camouflage drawings

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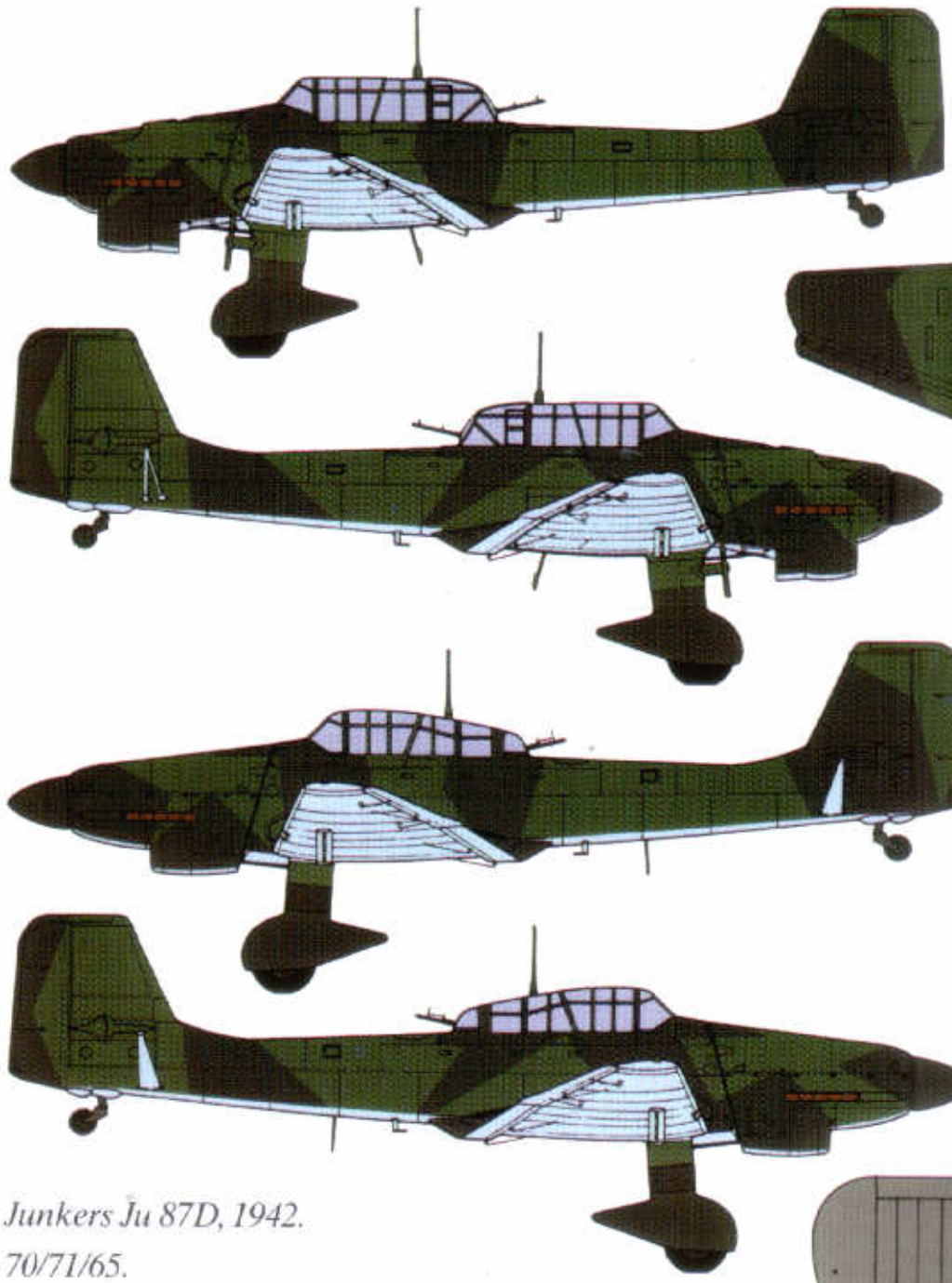
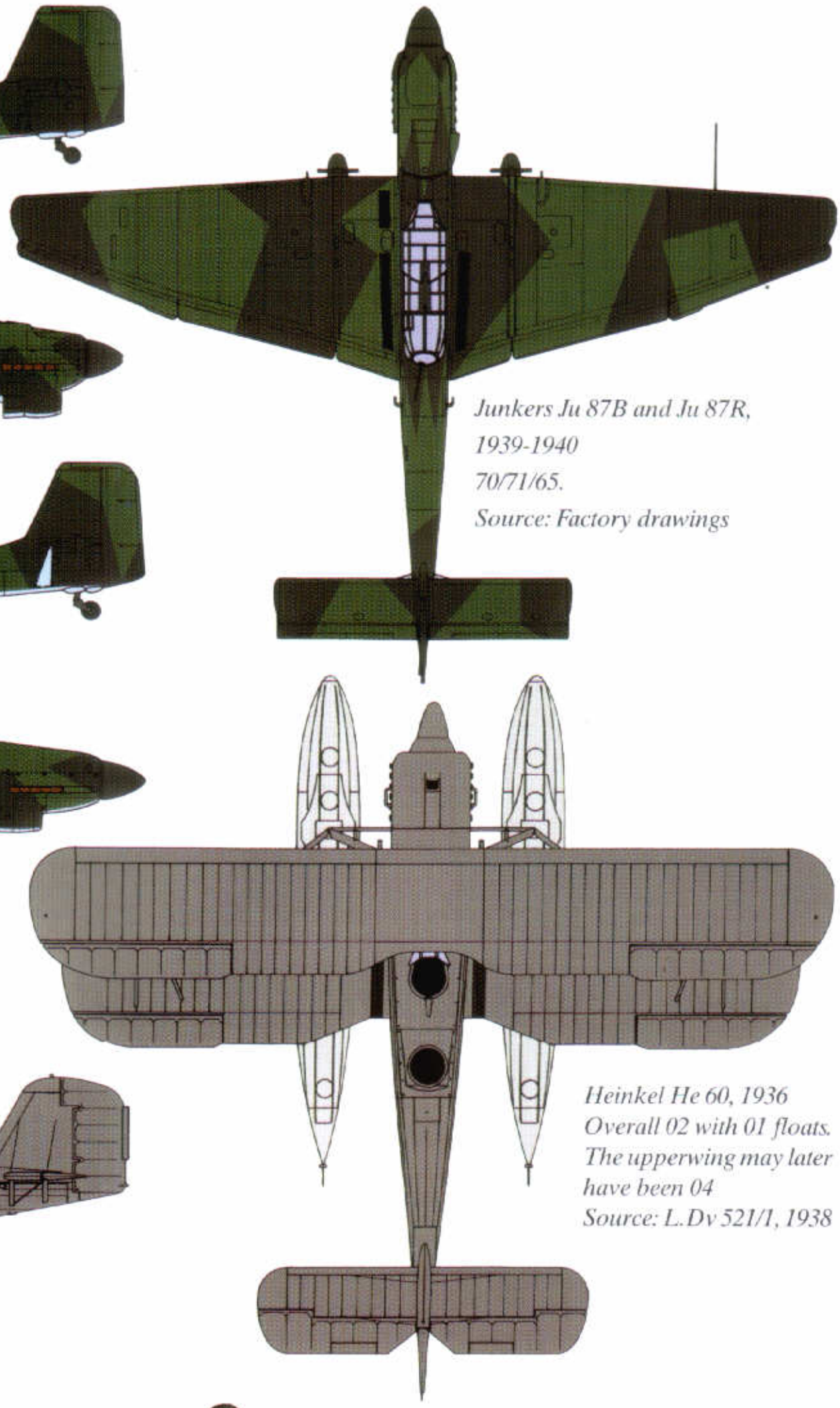
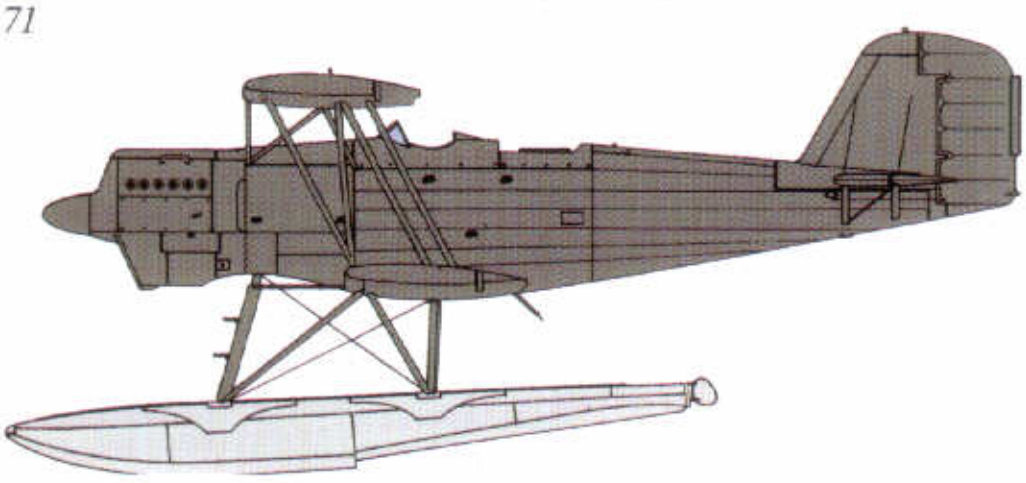
CAMOUFLAGE PATTERNS



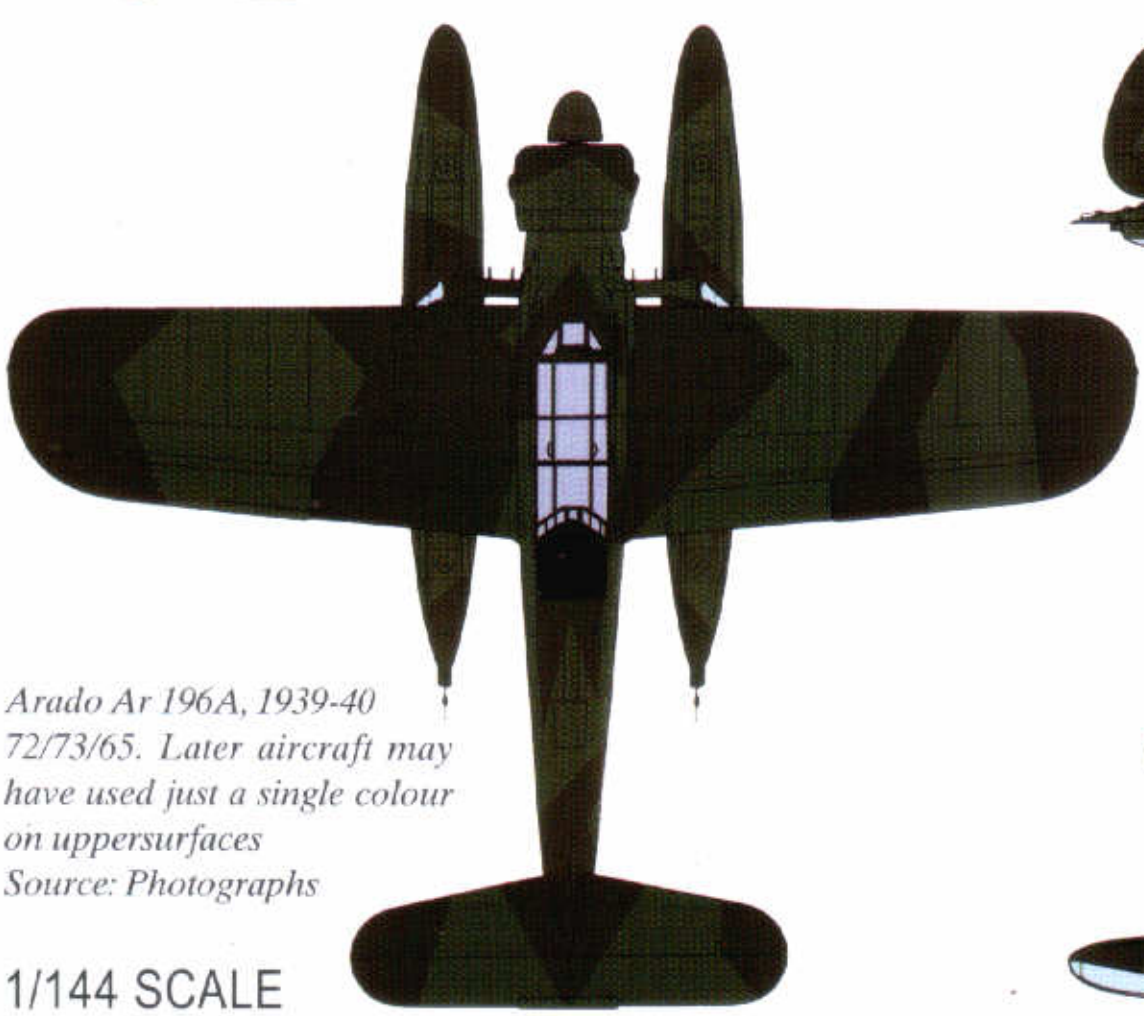
Junkers Ju 87D, 1942.
70/71/65.
Source: Photographs. This scheme seems to have used the same pattern as the Ju 87B, but as the war progressed, later production aircraft apparently used just a single colour, probably 71



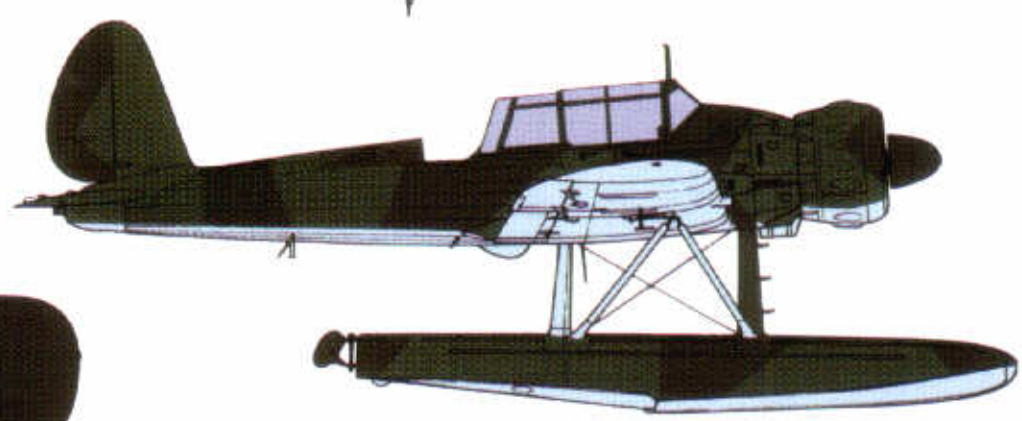
Junkers Ju 87B and Ju 87R,
1939-1940
70/71/65.
Source: Factory drawings

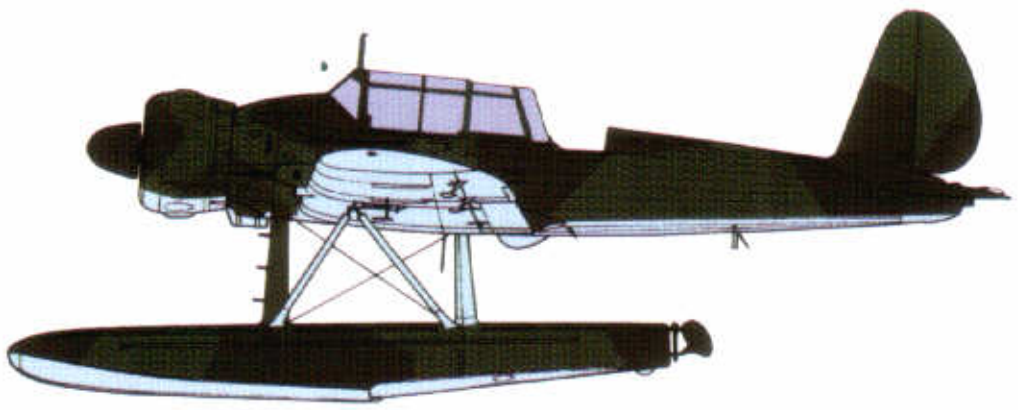


Heinkel He 60, 1936
Overall 02 with 01 floats.
The upperwing may later have been 04
Source: L.Dv 521/1, 1938



Arado Ar 196A, 1939-40
72/73/65. Later aircraft may have used just a single colour on uppersurfaces
Source: Photographs





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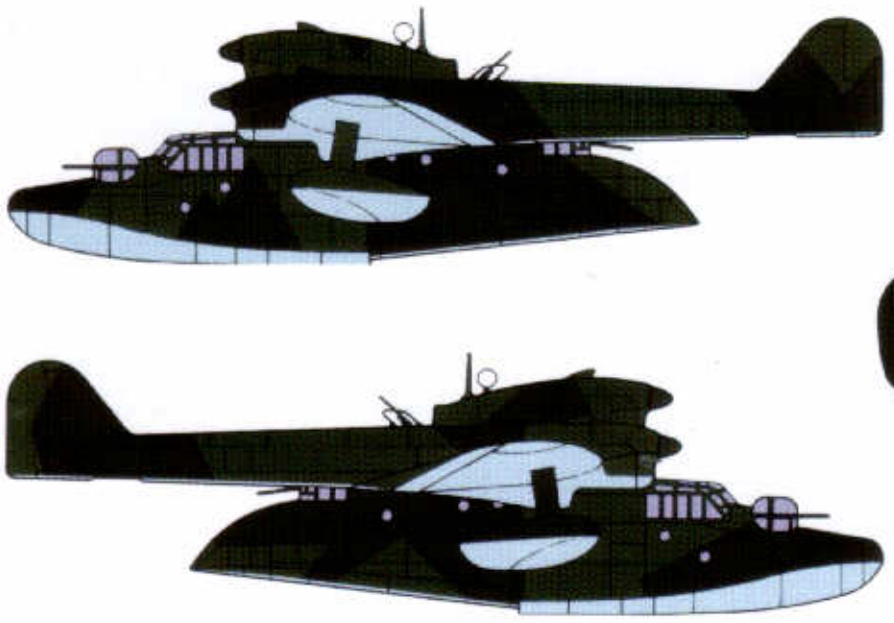
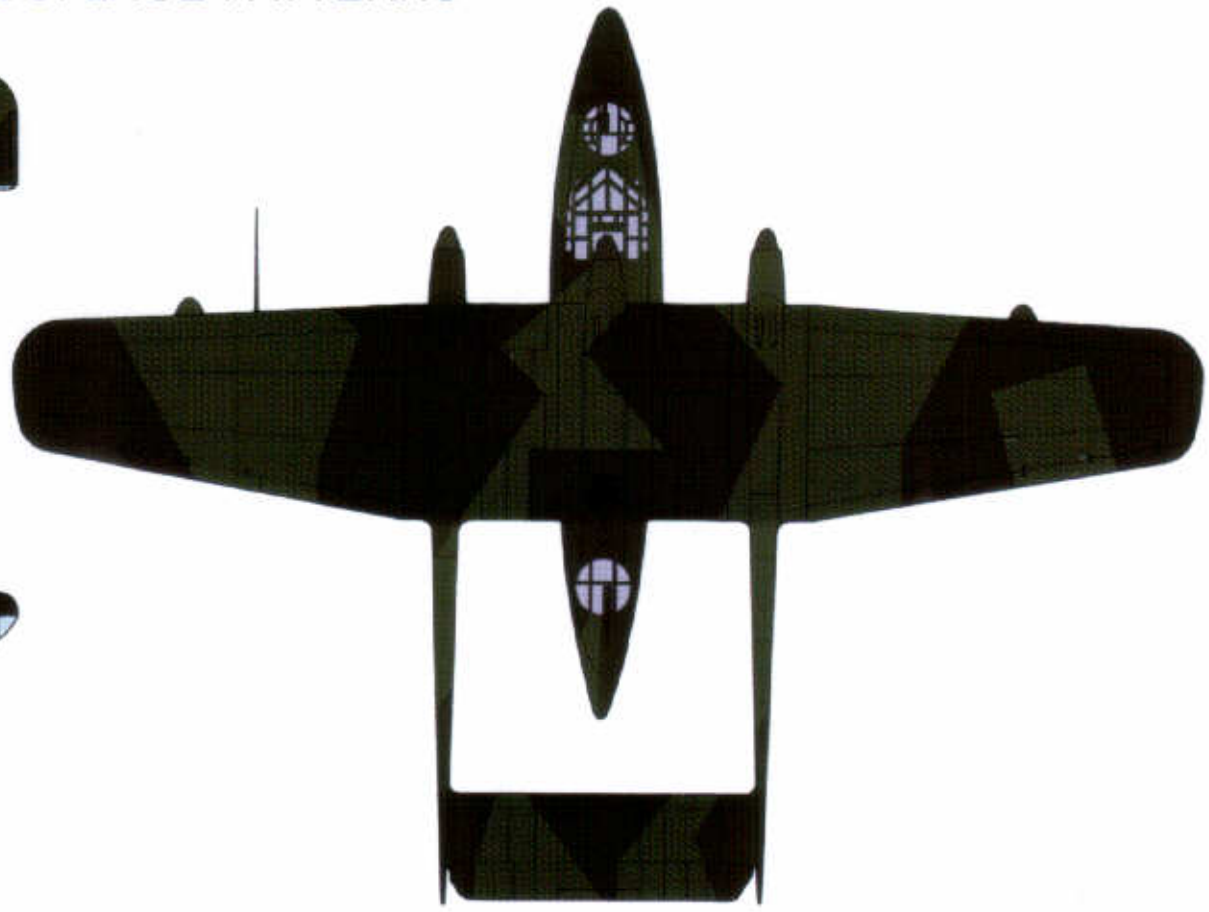
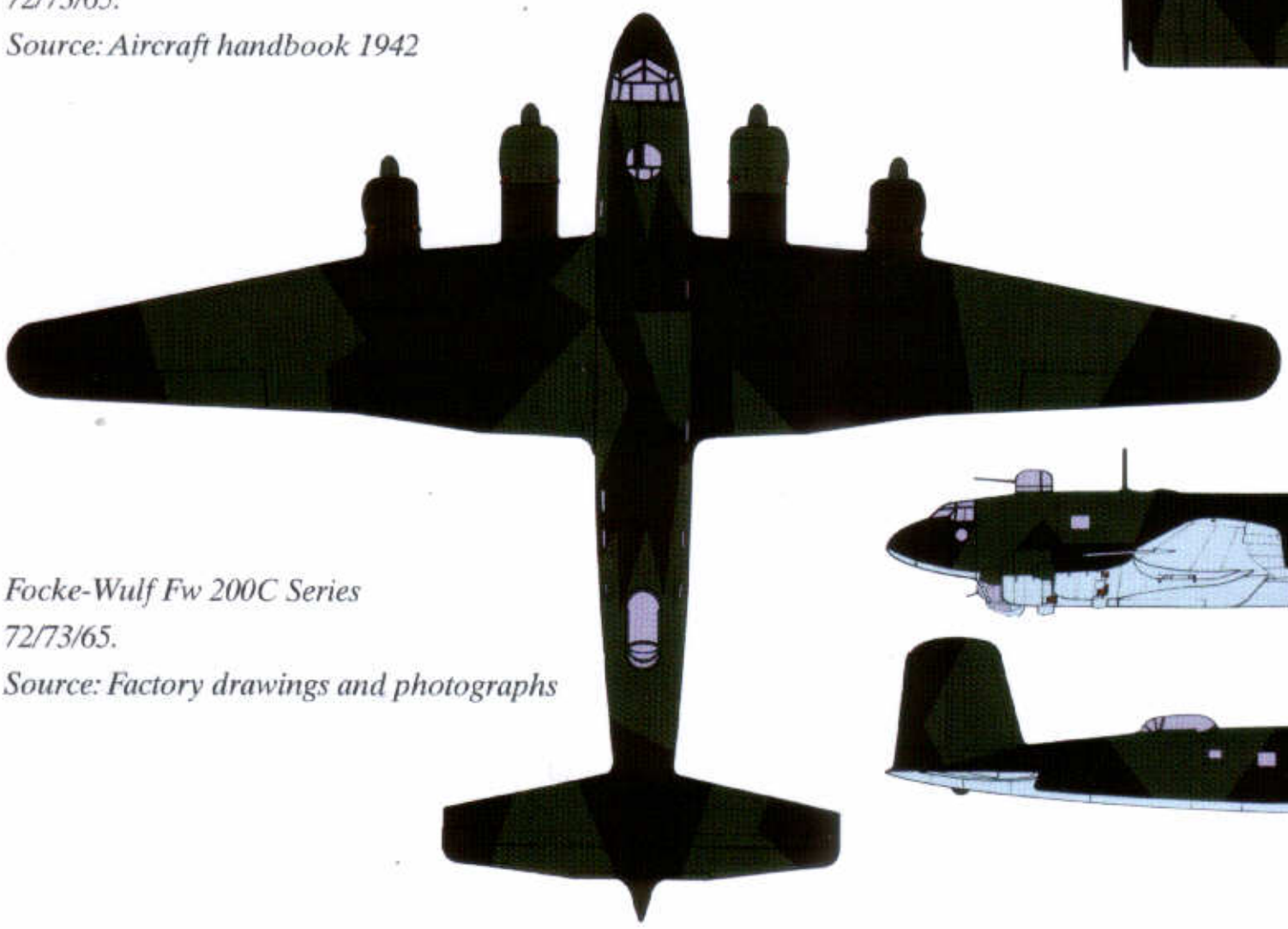
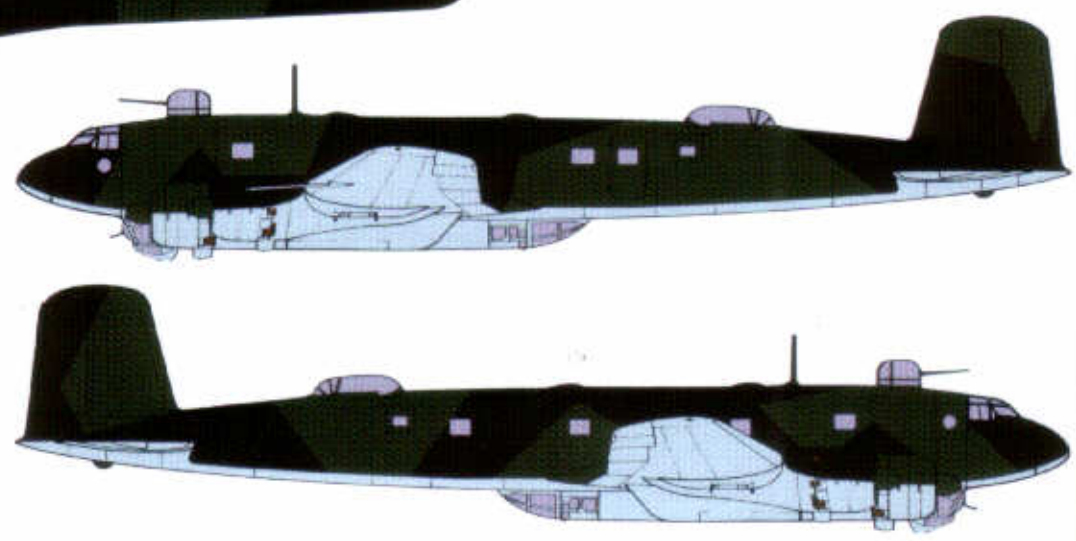


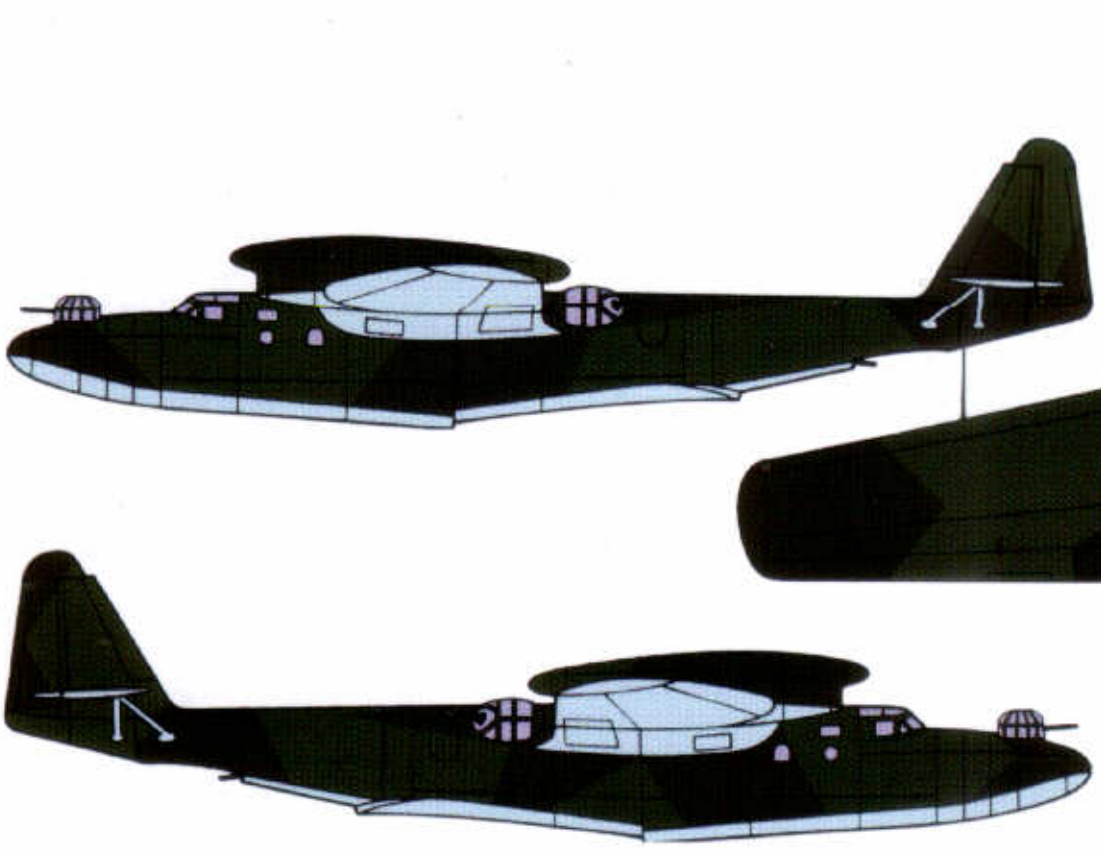
Blohm & Voss BV 138B and C
72/73/65.
Source: Aircraft handbook 1942

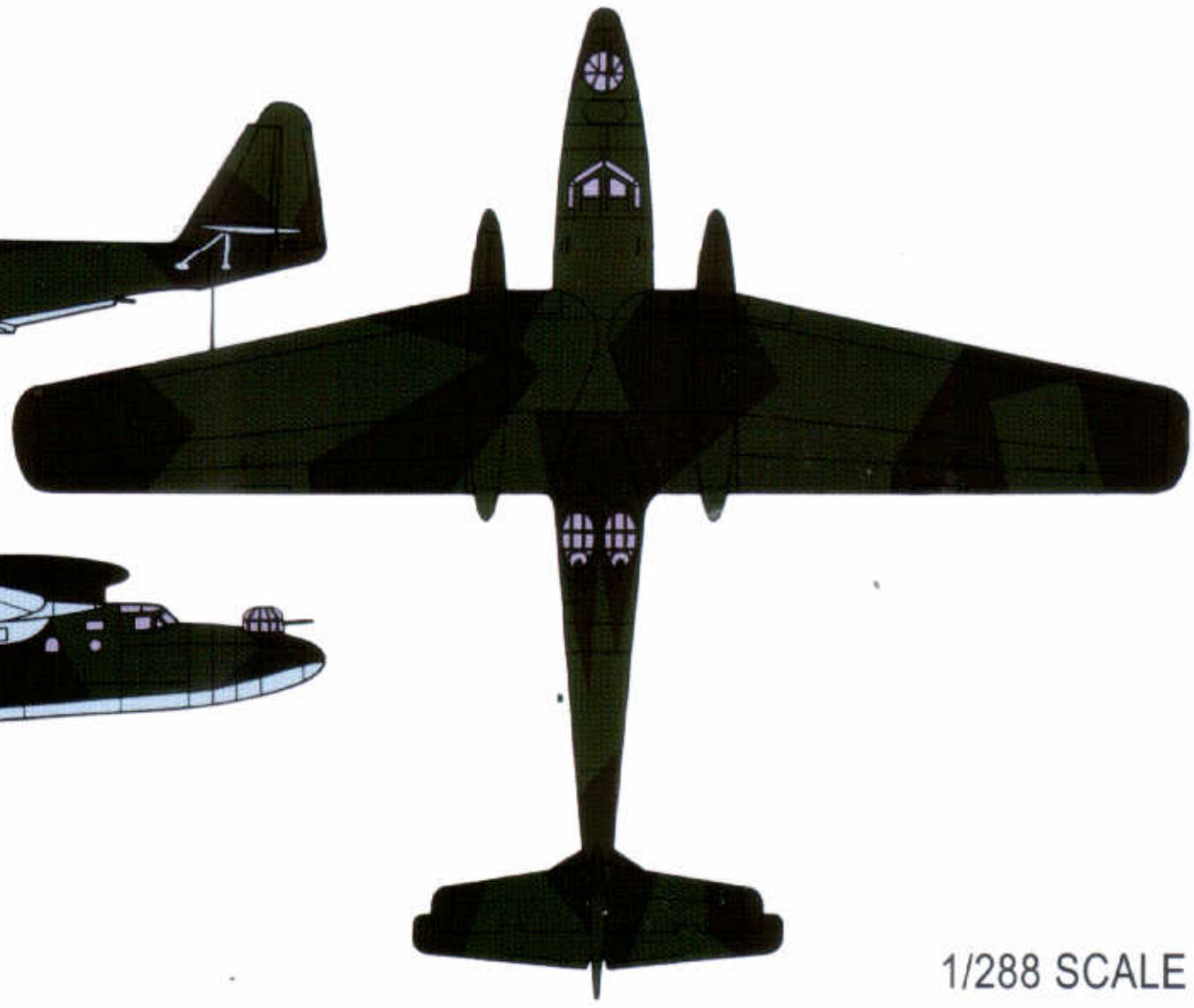




Focke-Wulf Fw 200C Series
72/73/65.
Source: Factory drawings and photographs







Dornier Do 26, 1939-1940
72/73/65.
Source: Factory drawings

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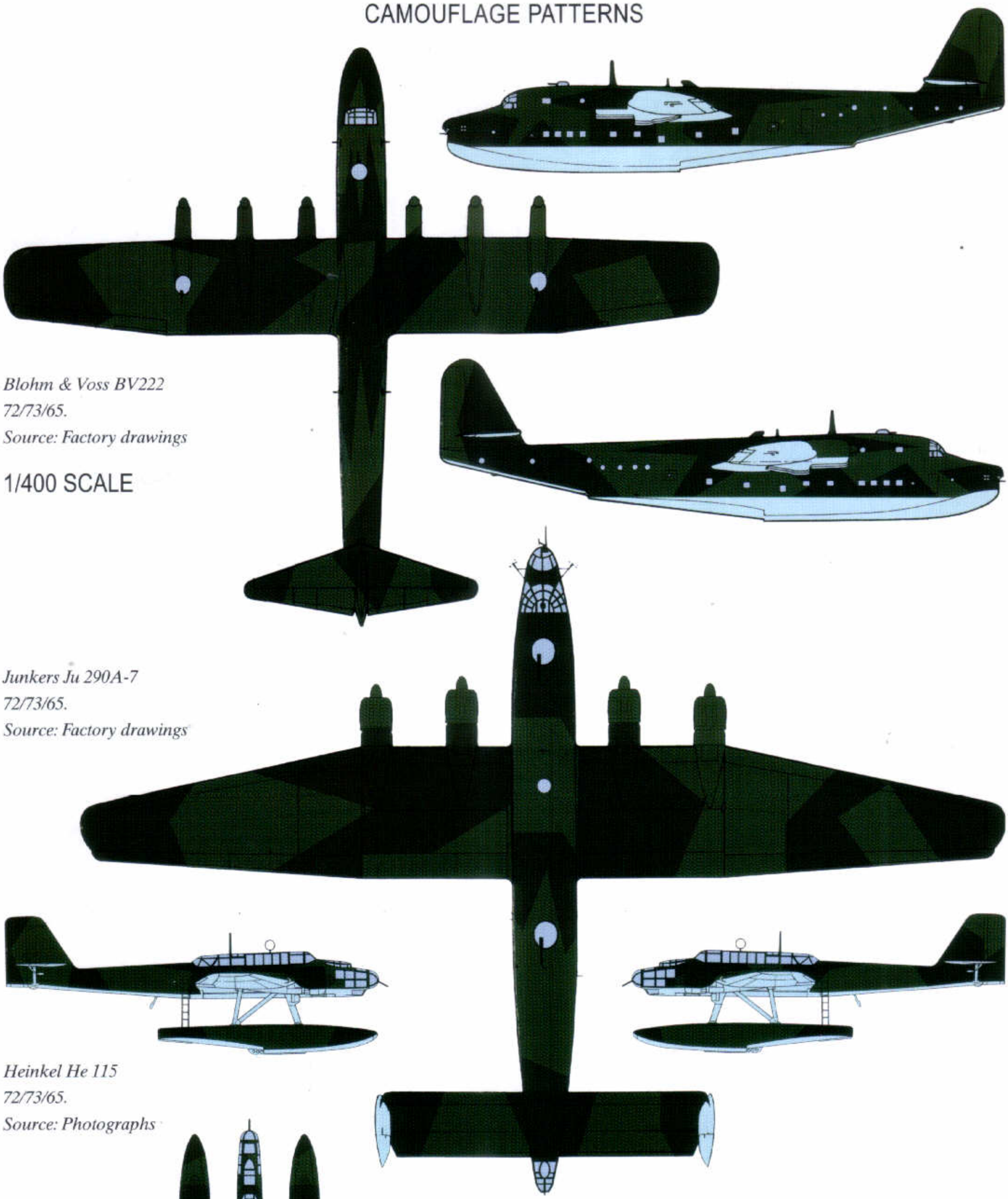
CAMOUFLAGE PATTERNS



Blohm & Voss BV222
72/73/65.
Source: Factory drawings

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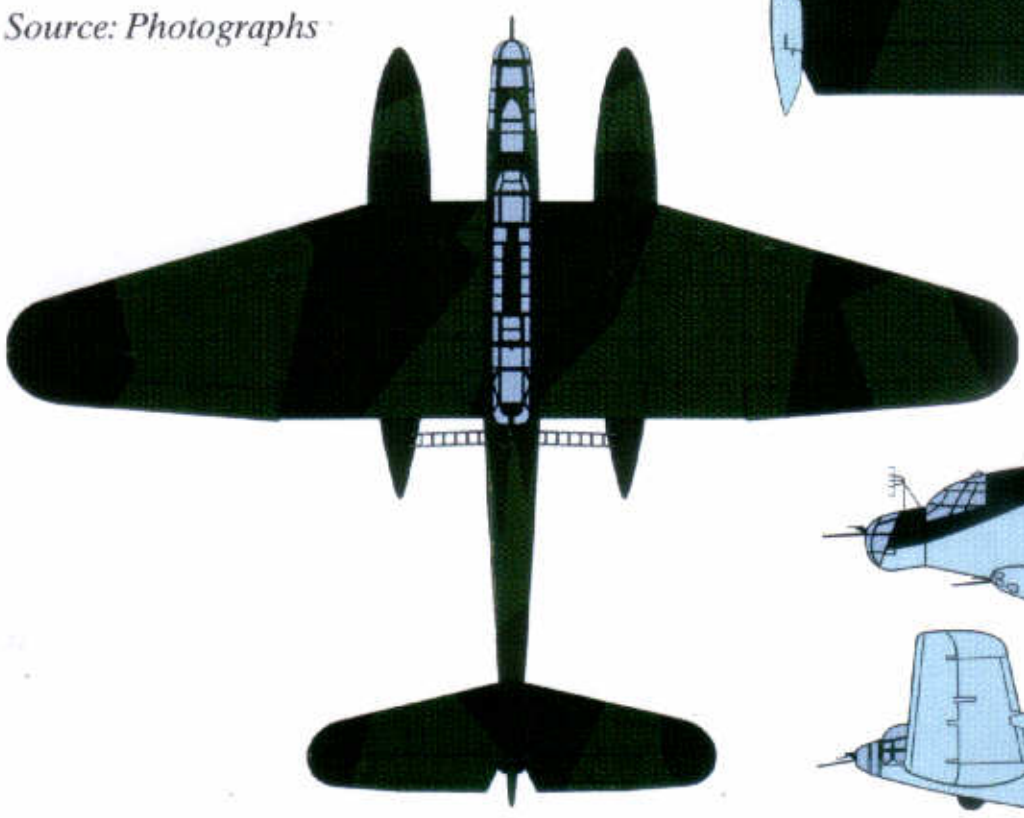
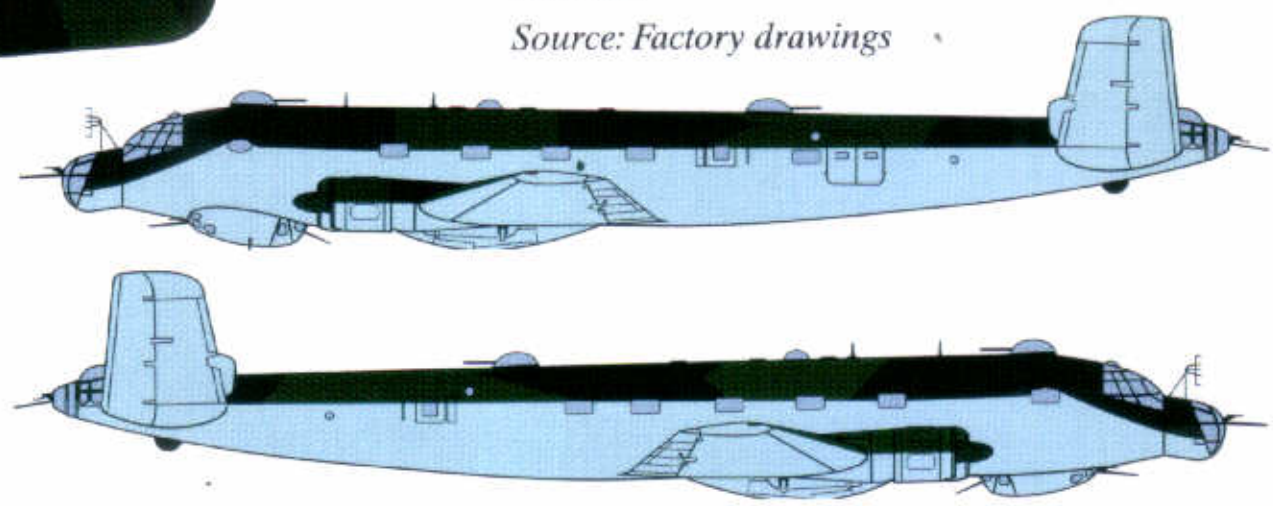
Junkers Ju 290A-7
72/73/65.
Source: Factory drawings

Heinkel He 115
72/73/65.
Source: Photographs



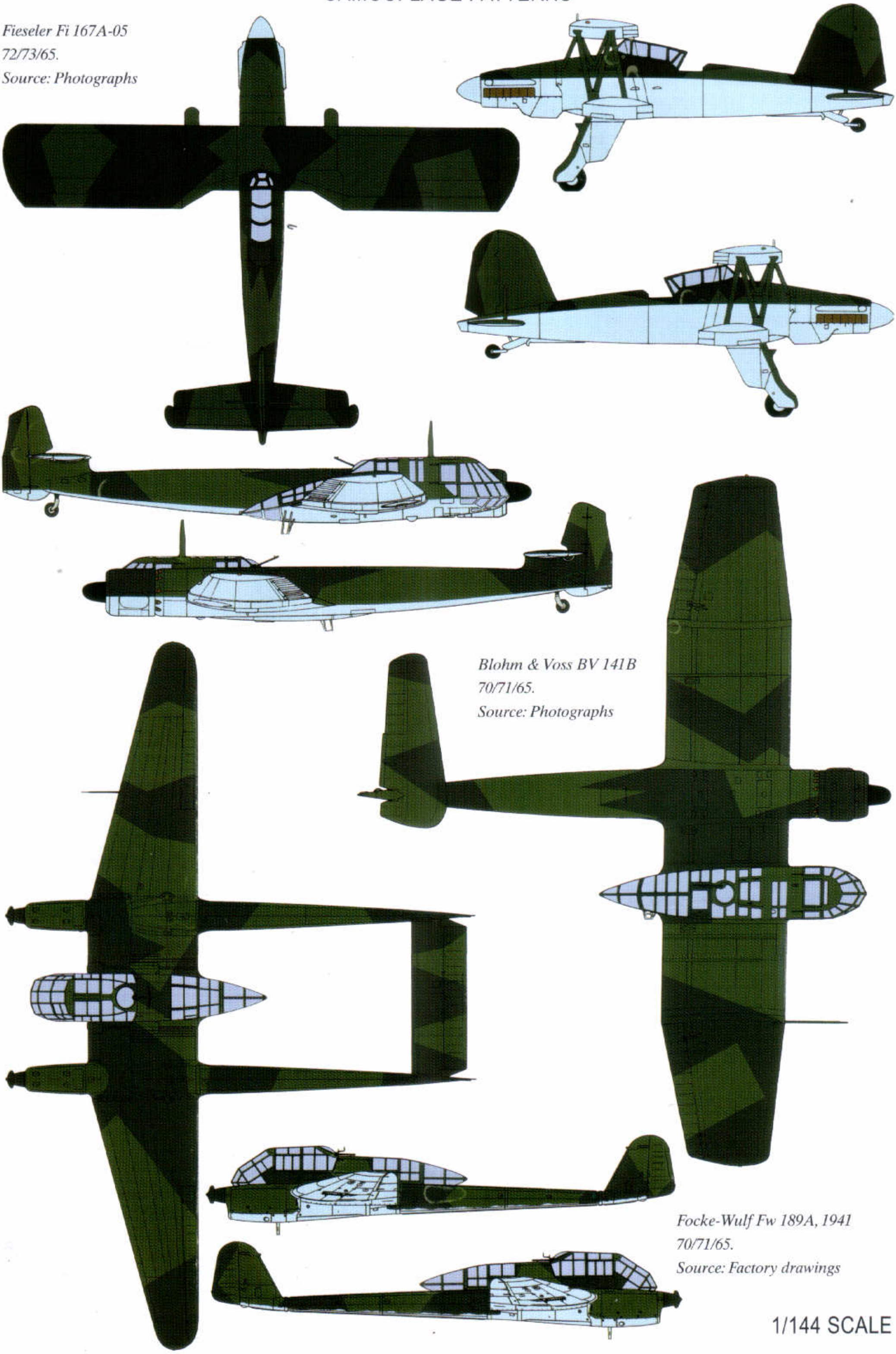
Junkers Ju 290A-7
72/73/65.
Source: Factory drawings



1/288 SCALE

CAMOUFLAGE PATTERNS

Fieseler Fi 167A-05
72/73/65.
Source: Photographs



Blohm & Voss BV 141B
70/71/65.
Source: Photographs

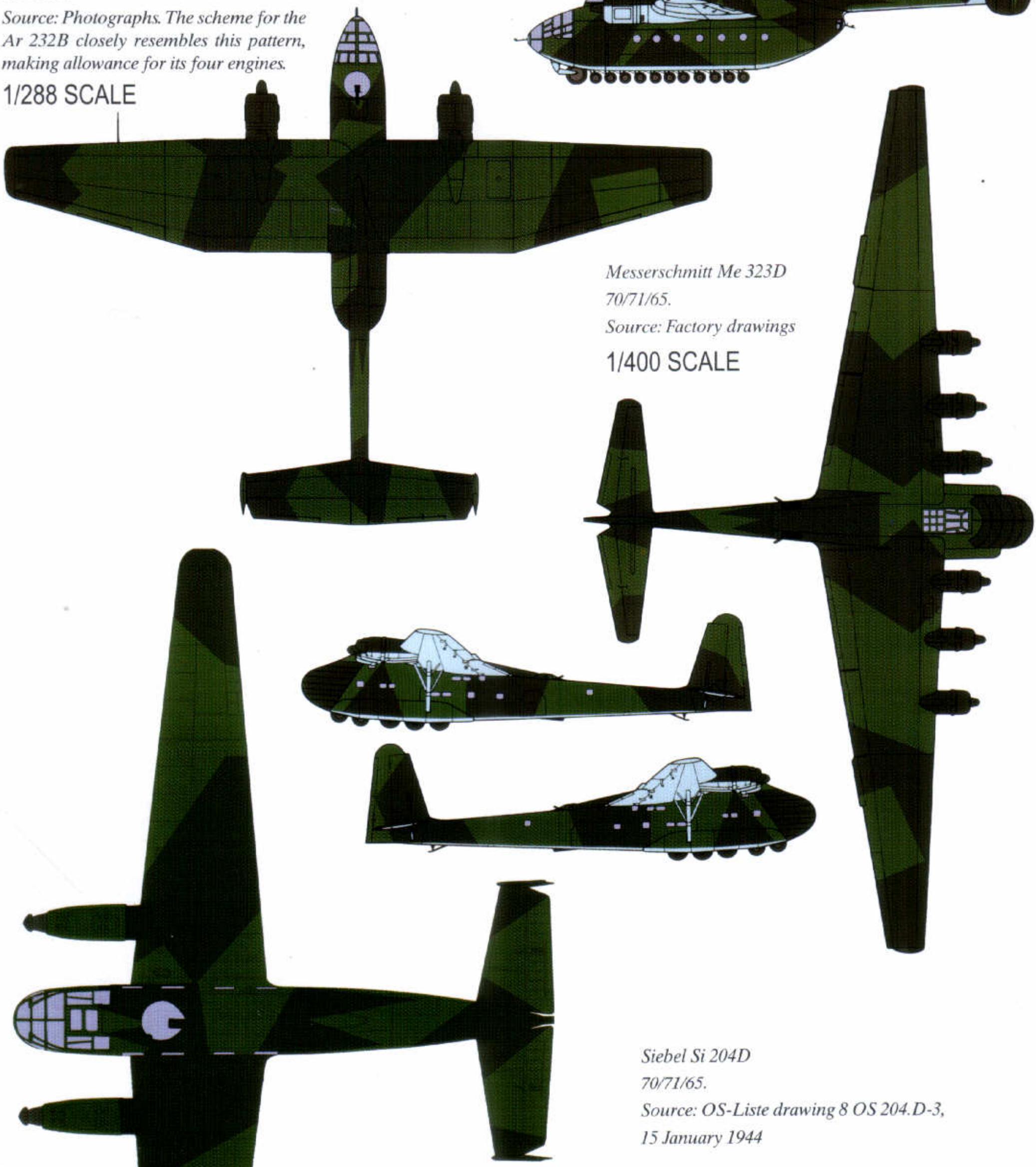
Focke-Wulf Fw 189A, 1941
70/71/65.
Source: Factory drawings

1/144 SCALE

CAMOUFLAGE PATTERNS

Arado Ar 232A Series
70/71/65.
Source: Photographs. The scheme for the Ar 232B closely resembles this pattern, making allowance for its four engines.

1/288 SCALE

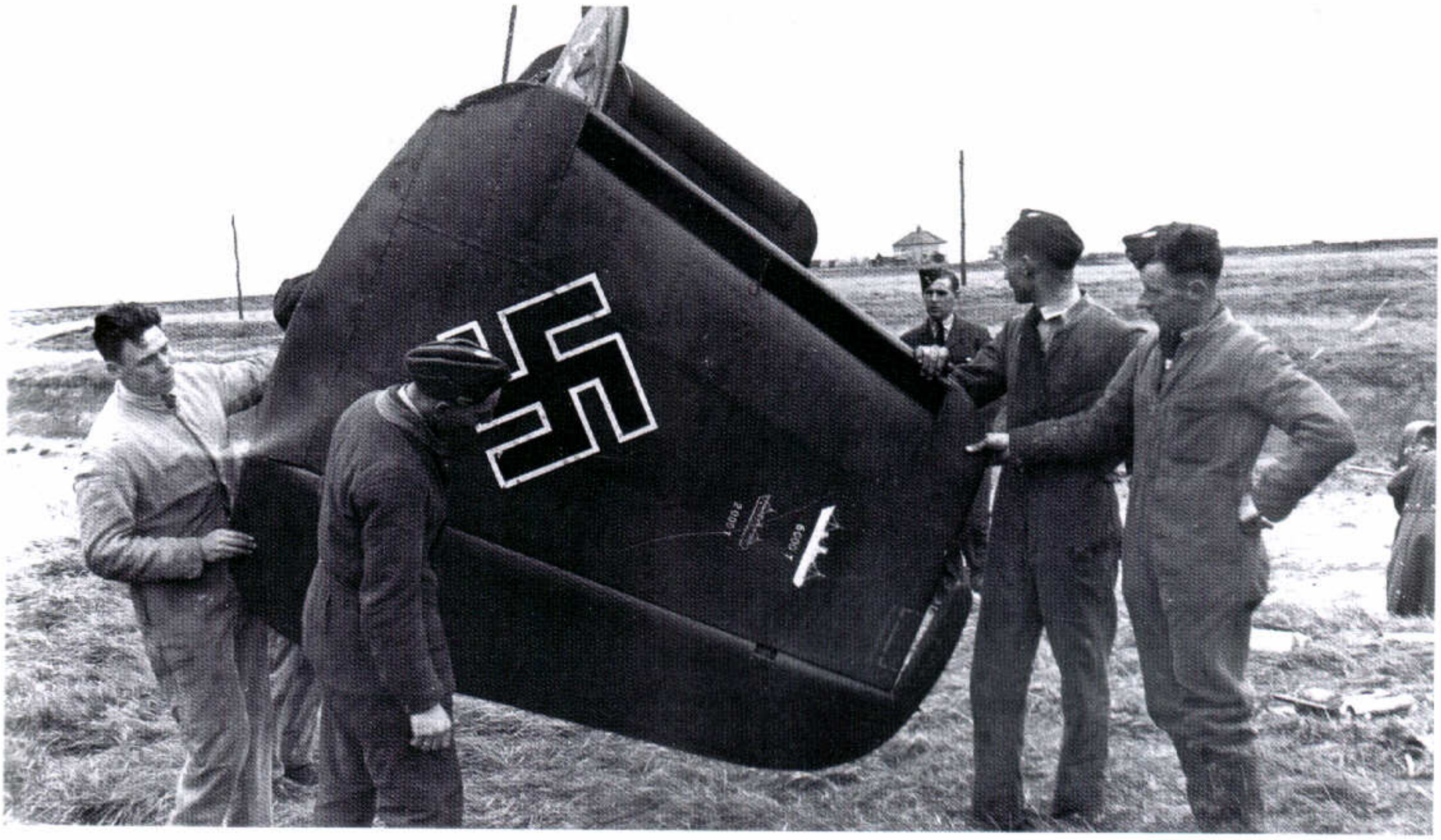


Messerschmitt Me 323D
70/71/65.
Source: Factory drawings

1/400 SCALE

Siebel Si 204D
70/71/65.
Source: OS-Liste drawing 8 OS 204.D-3, 15 January 1944

1/144 SCALE



MARKINGS AND INSIGNIA

Apart from the colours used for camouflage, numerous shades were introduced and used for other applications such as interiors, markings and insignia.

RLM No.	Designation	Purpose
RLM 02	RLM Grau	Interiors, camouflage
RLM 04	Gelb	Markings
RLM 21	Weiss	Markings, winter camouflage
RLM 22	Schwarz	Markings, night camouflage
RLM 23	Rot	Markings
RLM 24	Dunkelblau	Markings
RLM 25	Hellgrün	Markings
RLM 26	Braun	Markings
RLM 27	Gelb	Markings
RLM 28	Weinrot	Markings
RLM 66	Schwarzgrau	Interiors, camouflage
RLM 77	Hellgrau	Markings on night camouflage

Colours listed above were used for all kinds of markings, whether these were for lettering in the various colour shades, identification marks, instructions, call sign markings, theatre of war markings (for example, yellow for the East, white for the South), or the insignia of the various units and many other areas of use.

265 Above: *Members of the RAF recovery team study the kill markings on the tail fin of* Lt *Dolenga's Dornier Do 217E-1 (see photos 103, 221). The picture gives a perfect view of the standard style of swastika used throughout most of the war, here 420mm square (see page 152). Note the dotted red line on top of the fin indicating the position for the gust lock*

Regulations on the marking of aircraft

There were precise directives governing the execution of all markings on aircraft of the German Luftwaffe. To provide a general overview, these are reproduced in full here. The following section has been extracted from the Reich Law Gazette No. 78 of 29 August 1936:

"**National and Registration Markings, 1936**
The national marking carried by German aircraft and airships is the letter D, four additional letters comprise the registration marking. For airships the Reich Minister for Aviation may permit non-standard registration markings.

Aircraft carry the national marking D and the registration marking on both sides of the fuselage between wing and tail unit, monoplanes additionally on both surfaces of the wings, biplanes on the undersides of the lower wings and the top surfaces of the upper wings.

Airships carry the markings at the point of their largest circumference on both sides of the envelope, so that they are visible from the sides and from the ground, and also on the top of the envelope at the same distance from, and at right angles to, the side markings.

"The markings are to be indelibly applied either in dark square capitals on a light background, or light square capitals on a dark background, and are to be maintained in a clearly visible condition. The national marking D is to be separated from the registration marking by a hyphen with a length of one character width. The characters should occupy a rectangular field and be as large as possible without being obscured by components such as e.g. engine nacelles, struts, wheels or floats.

In the case of aircraft the shortest distance between the lettering field on the wings and the wing edges should, at its narrowest point, be no less than a sixth of the character height; with airships the height of the characters on the envelope should be a twelfth of the circumference at its largest cross-section, but should not exceed 2.5 m.

Towed aircraft, which have been registered and licensed, carry the national marking D and the registration marking in the same way as powered aircraft,

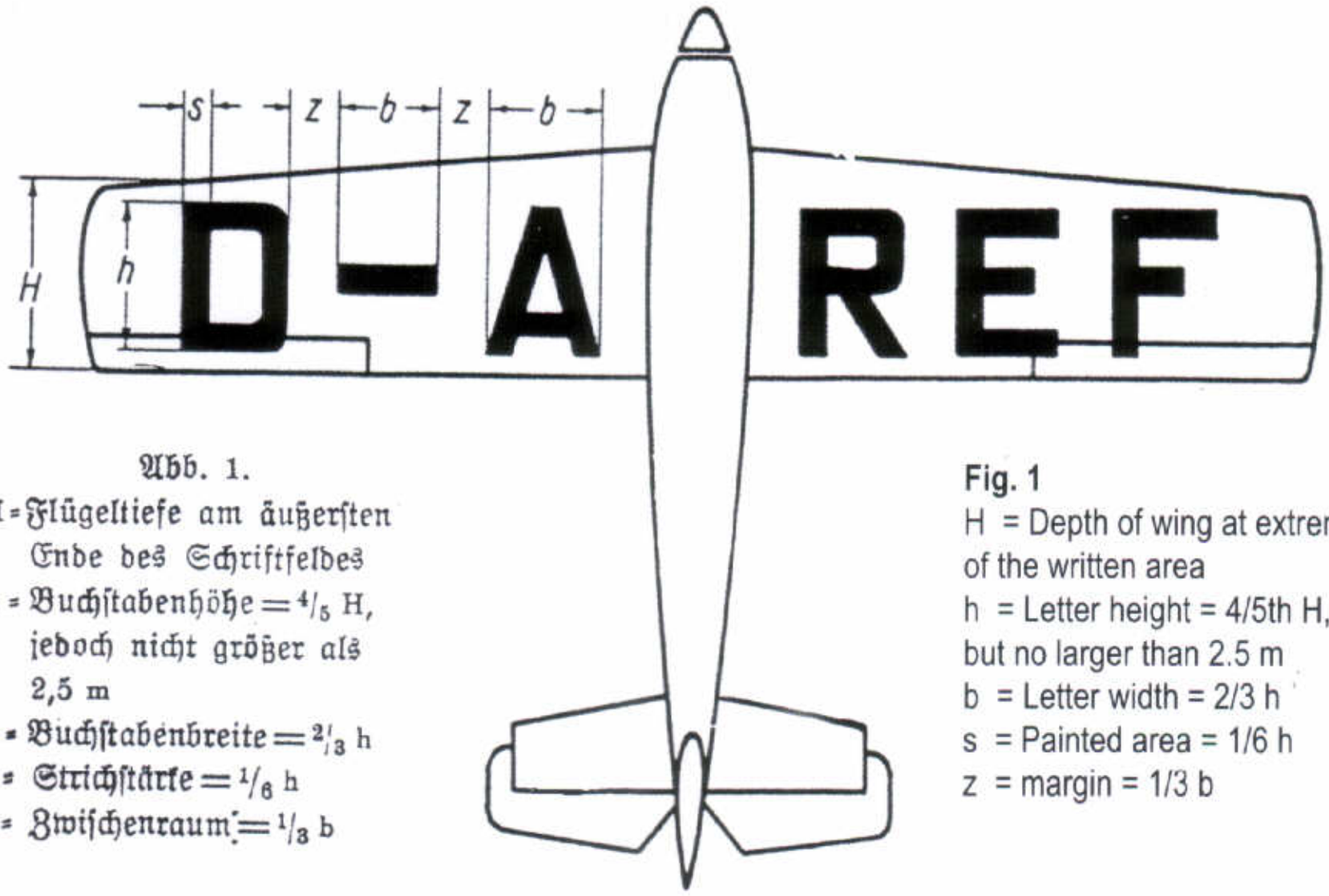


Abb. 1.
H = Flügeltiefe am äußersten Ende des Schriftfeldes
h = Buchstabenhöhe = 4/5 H, jedoch nicht größer als 2,5 m
b = Buchstabenbreite = 2/3 h
s = Strichstärke = 1/6 h
z = Zwischenraum = 1/3 b

Fig. 1
H = Depth of wing at extreme end of the written area
h = Letter height = 4/5th H, but no larger than 2.5 m
b = Letter width = 2/3 h
s = Painted area = 1/6 h
z = margin = 1/3 b

Fig. 2
H = Fuselage height at tailplane (rear end of the written area)

266 Below left, 267 Right: *These extracts from the* Flugzeugmaler *(The Aircraft Painter) for 1939 shows how the national markings, the Balkenkreuze and the identification markings on military and civil aircraft were to be applied in the pre-war period*

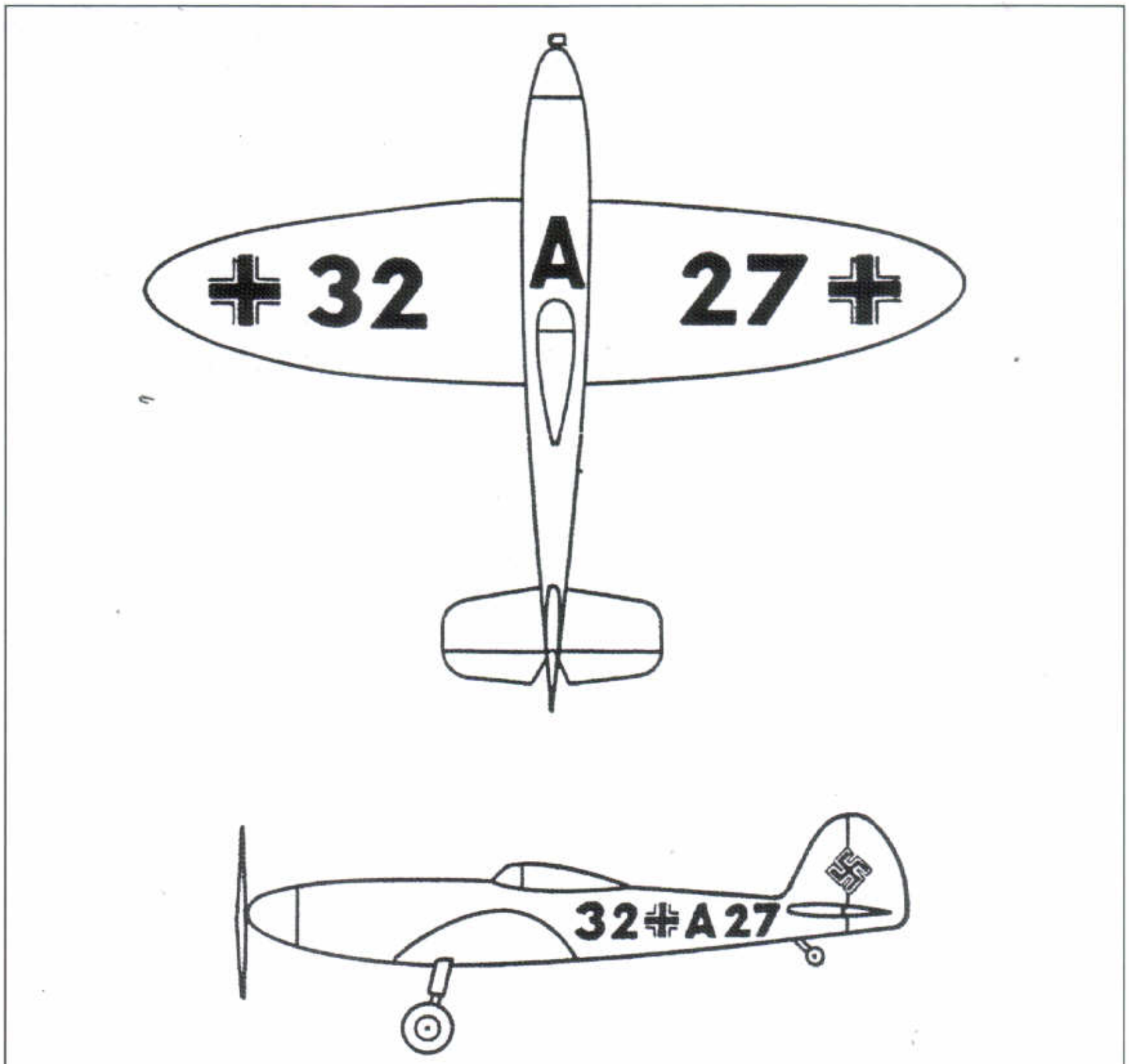


Fig. 3 Markings of military aircraft

"but these markings should be underlined with a continuous line.

Gliders flown outside recognized glider areas carry the national marking D similar to the above mentioned powered aircraft markings.

Free-flying balloons carry the national marking D and their name in accordance with the regulations for markings on airships.

Reich and National Flag

Aircraft and towed aircraft carry the Reich and national insignia in colour on both port and starboard sides of the vertical tail surfaces. The colour marking must be of equal size on both sides and its dimensions must be such that it occupies at least half the height of the vertical tail surfaces above the tailplane and provides a ratio of approx. 3:5 in flag height to length on each side.

The colour application is to be arranged as follows: Inside the red stripe is a white disc containing a black swastika, whose arms are canted at 45 degrees. Red stripe, white disc and swastika have a common centre point. The angle of the swastika nearest to the leading edge of the tailfin is open to the top. Diameter of the white disc equals three-quarters of the height of the red stripe. Length of the main bars of the swastika equals half the height of the red stripe. Width of the main bars and angled arms of the swastika, and their distance from each other, equals a tenth of the height of the red stripe.

Airships carry the Reich and national insignia in colour on both port and starboard sides of the vertical control surfaces. The size of the flag and the dimensions of the colour area are decided in each individual case by the Reich Minister for Aviation!

Gliders carry the Reich and national insignia as described above for powered aircraft.

Free-flying balloons fly a swastika flag.

Aircraft which, for reasons of design or otherwise, make the application in the prescribed form impractical, are issued with suitably amended markings as directed by the Reich Minister for Aviation.

268: *The Reich insignia as it was to be applied in the pre-war period*

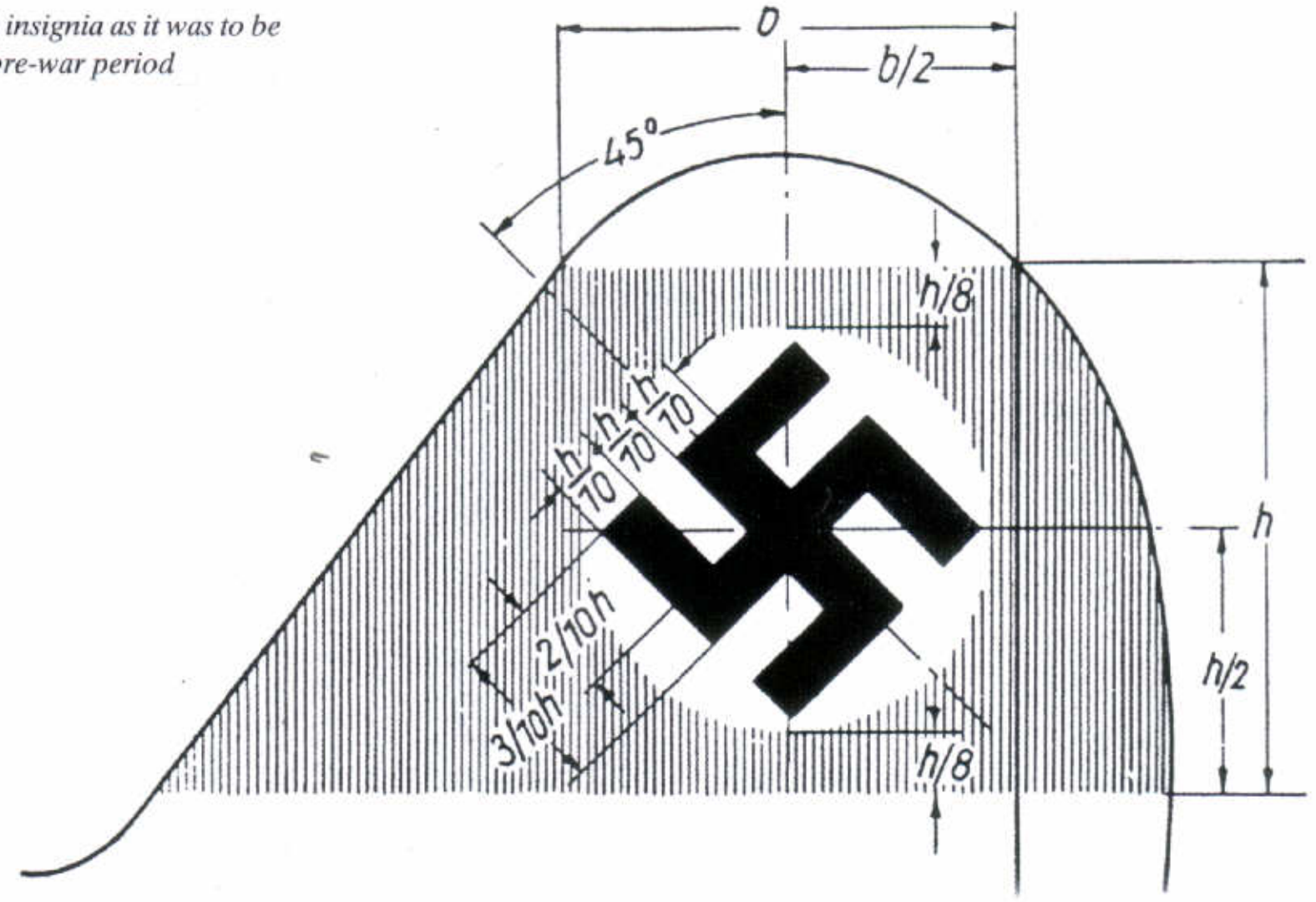


Fig. 4

"**Other Markings**
On the fuselage, wings and wing components of aircraft, the name and address of the manufacturer, type, serial number and year of manufacture of the component concerned should be displayed, clearly visible, preferably on a fixed plate. In addition, on the left side of the fuselage the following should be specified on a light background in dark letters at least 25 mm high and 4 mm thick:

a) Name and address of the owner

b) Tare weight, load and max. permissible all-up weight

c) Max. permissible number of people, including crew

d) Dates of last inspection and next check

Similar information should be displayed at a clearly visible location inside the gondolas of airships.

In the cargo hold a loading plan in diagram form should be displayed in a clearly visible location.
On engines a metal plate, giving the following information, should be affixed in a clearly visible location:

a) Name and address of the manufacturer

b) Type, model, serial number and year of manufacture

c) Full-load and max. permissible RPM

For the display of advertisements the following deviations are permissible:

On biplanes the markings should be executed as follows:

National Marking D & Registration Marking	**Advertisement**
Upper surface of top wing (prescribed size)	Underside of the lower wing
Underside of the upper wing (prescribed size)	
Underside of fuselage (prescribed size)	
Rear third of fuselage sides (as large as possible)	The front third of fuselage sides

On monoplanes correspondingly:

National Marking D & Registration Marking	**Advertisement**
Upper surface of wing (prescribed size)	Underside of wing
Underside of fuselage (prescribed size)	
Rear third of fuselage sides (as large as possible)	
Underside of stabilizer or elevator (as large as possible)	The front third of fuselage sides

Where several aircraft display the same marking, a clearly differentiating sign should, if possible, be provided e.g. by way of a number (Trumpf I, II...). Aircraft employed in commercial airline service are not permitted to carry advertisements! The use of aircraft bearing advertisements must be restricted to domestic flights. Requests for exceptions must be submitted via the Air Office to the Reich Minister for Aviation.

Aircraft and airships engaged on test flights with blind flying equipment or autopilot devices carry two pale yellow bands around the fuselage as an identification marking. Apart from the red stripe of the national insignia, the use of red paint on aircraft and airships is not permissible!

Aircraft Position Lights and their Special Identification on Water

The following regulations apply under all weather conditions between sunset and sunrise. During this period no other lights may be shown, which could be confused with those described below.

The term "visible" means; visible on a dark night in clear air.

The visual angles dealt with below, and the terms "right", "left" and "rear", refer to an aircraft in a normal position, in horizontal forward flight, or at rest on the ground or water.

In the air, or while at an airport, aircraft must display the following position lights:
a) on the right (starboard) side a green light arranged in such a way that it throws an uninterrupted beam over a horizontally measured angle of 115°; this being bordered by two vertical planes in the direction of flight, of which the left one is parallel to the longitudinal axis of the aircraft. It must have sufficient light intensity in the direction of flight for the beam to be visible for approx. 8 km. Within the specified dihedral angle the light intensity in all directions may not fall below the following values (*refer to diagram below*):
Overlapping of the light angle in direction of flight is permissible, if within the 0° to 10° angle to the direction of flight the light intensity reduces from 100% to 0%.
b) On the left side is fitted a red light which — as per the arrangement described above — also illuminates an angle of 115°, whose right vertical plane is parallel to the longitudinal axis.
c) At the rear, as far aft as possible, is a white tail light with an uninterrupted beam illuminating a hemispherical area whose base plane is vertical to the longitudinal axis of the aircraft. It must be visible within this hemisphere for 4 km.
Aircraft moored on water must display the following position lights:
a) An aircraft which can move under its own power on water (manoeuvrable aircraft) has to set the position lights described above. In addition it must carry a white light on the bow which throws an uninterrupted light angle of 225°. Its median line must correspond to the aircraft's longitudinal axis. The light intensity must be sufficient for it to be visible for 8 km on a dark night. This light intensity must be provided over an angle from 5° below to 20° above the horizontal plane of the aircraft when afloat.
b) A towed aircraft has to carry the normal position lights without the bow light.
c) An aircraft which is no longer manoeuvrable has to display two red lights positioned vertically one above the other, distanced at least 1 m apart, and so positioned that they can be best seen from all directions.

The position lights of non-manoeuvrable or anchored aircraft must be visible for at least 2 km.

Airships must also comply with the above regulations regarding the lighting arrangement for powered aircraft.

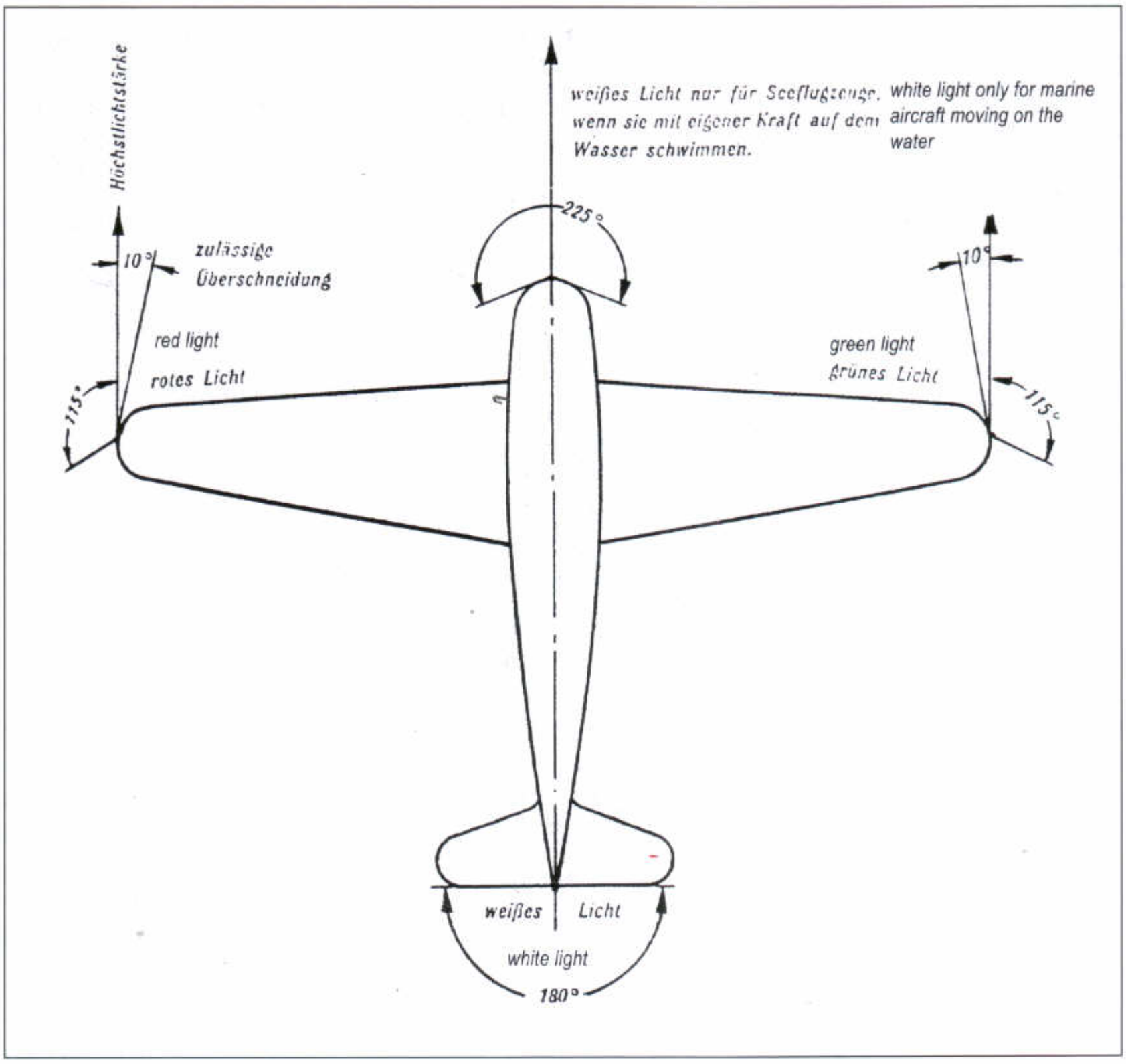
Gliders have to make their presence known by means of light signals when other aircraft are approaching.

During night flights free-flying balloons must carry electric spotlights with an incandescent bulb of at least 20 Watts and a radiation angle of at least 30°.

If another aircraft comes into the vicinity of the balloon, the balloonist has to flash signals, of 1 second duration followed by a 1 second pause, alternately illuminating the balloon envelope and then in the direction of the oncoming aircraft.

In the case of aircraft, whose design makes attachment in the prescribed form either impossible or extremely difficult, the Reich Minister for Aviation determines the type of provision to be made.

Angle to direction of flight	0_i	10_i	20_i	30_i	40_i	60_i	80_i	115_i
Light intensity in % of the light intensity in direction of flight	100%	94%	78%	59%	40%	21%	15%	19%



269 Left: *Diagram showing the layout and functioning of aircraft position lights with particular reference to marine aircraft on the water*

270 Right: *The official diagram accompanying the instruction changing the style of the swastika dating from 1 January 1939*

271 Lower right: *The standard style for numerals and letters to be carried by all German aircraft*

Changes to aircraft markings 1939

Luftwaffe Regulation Notice No. 5 of 30 January 1939 ordered the following change to the Luftwaffe's national markings:

"With effect from 1.1.1939, the following amendment applies to the marking of Luftwaffe aircraft (military aircraft):

1. Instead of the Reich and national flag, all aircraft of the Luftwaffe will bear the swastika as per annex.

2. The military identification markings at present applying (Balkenkreuz and numbering) remain unchanged.

3. Aircraft belonging to squadrons, training schools and other Luftwaffe units not bearing military markings (see Fig. 2) will receive the letters 'WL' instead of the 'D', the letter series otherwise remaining unchanged."

The Luftwaffe Regulation Notice goes on to say:

"1. The swastika retains its existing dimensions.

2. The swastika receives a white margin amounting to one-sixth of the breadth of the bar.

3. The white edging is limited on the outside by a black line, of a width of one quarter of the white edging.

4. All other parts of the existing national markings on a red base will be sprayed with camouflage shade 70 for 2 tone camouflage and camouflage shade 61 for 3 tone camouflage.

5. When this is done, the swastika, including the edging referred to in items 2 and 3 will be protected with masking tape. The uncovered parts of the original national marking will be roughed up with careful wet rubbing down.

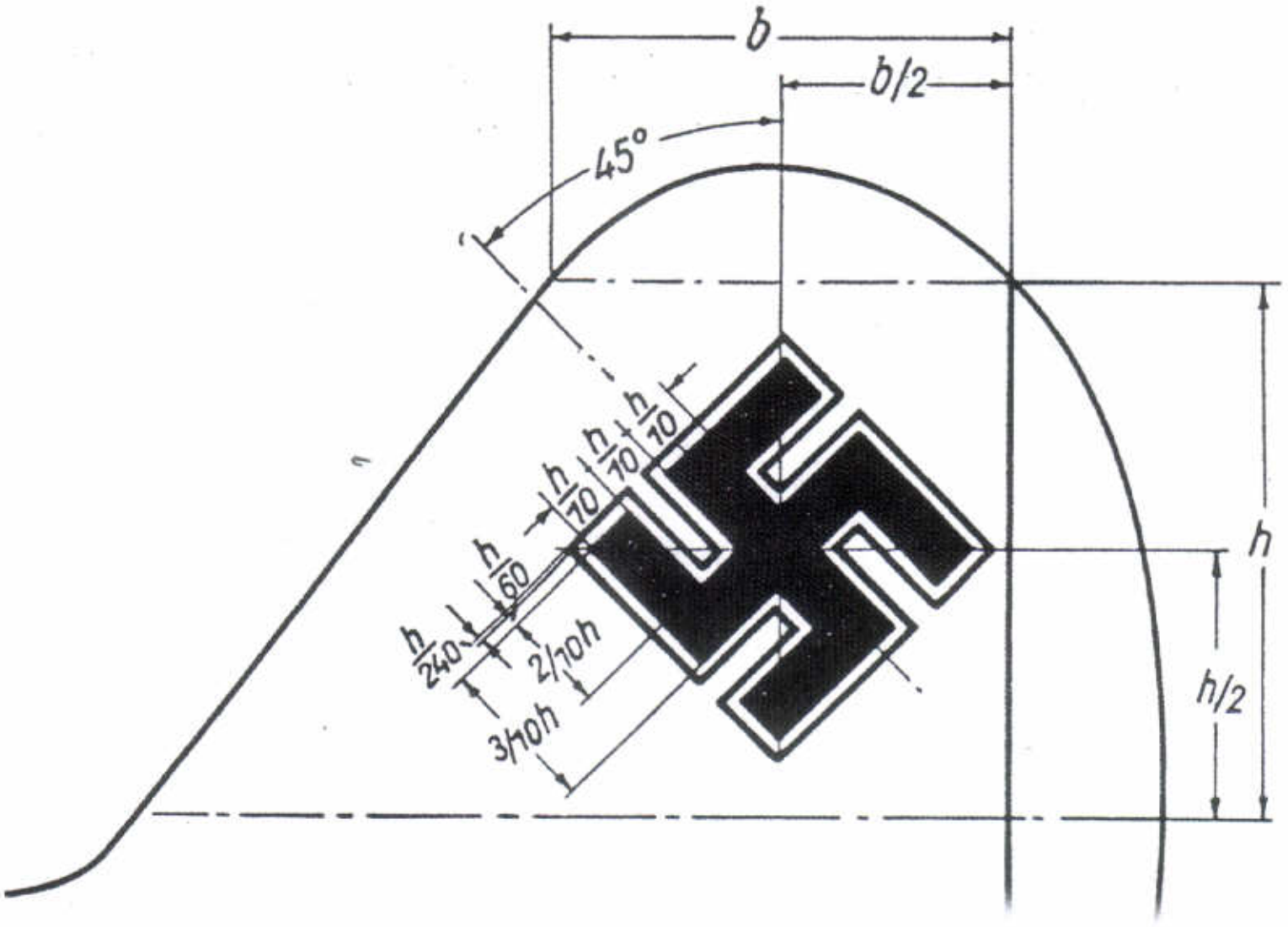
6. When fully dry, parts so treated will be sprayed with shade 70 or 61.

7. Finally, the black edging line (3) will be outlined in shade 22."

Markings 1943

The *Flugzeugmaler* (The Aircraft Painter) for 1944 contains the following passage: (*Note that this is repeatedly broken up with explanatory drawings, as in the original*)

"**1. Registration and Staffel Designations**
Markings on aircraft are executed in block form, irrespective of whether they are numbers or letters. Par-



ticular care has to be taken to ensure that the bars are of equal thickness. In lettering a distinction is made between letter height, width of the letters, thickness of the lines and the distance between letters. The spaces must be arranged so that they appear of equal width. Irregular spacing results in a distorted lettering image.

The letters C, E, F, J and L are drawn slimmer; otherwise they would appear to be too wide. Both M and W are appreciably wider.

Lettering dimensions:
Height of letter = $^{6}/_{10}$ the size of the Balkenkreuz
Width of letter = $^{4}/_{10}$ the size of the Balkenkreuz
Thickness of letter = $^{1}/_{10}$ the size of the Balkenkreuz
Spacing = $^{2}/_{10}$ the size of the Balkenkreuz

The centre line of the height of the letters is the centre line of the Balkenkreuz. It runs parallel to the horizontal line of flight, not to the fuselage centre. On wing upper and lower surfaces the centre line is at right angles to the direction of flight.

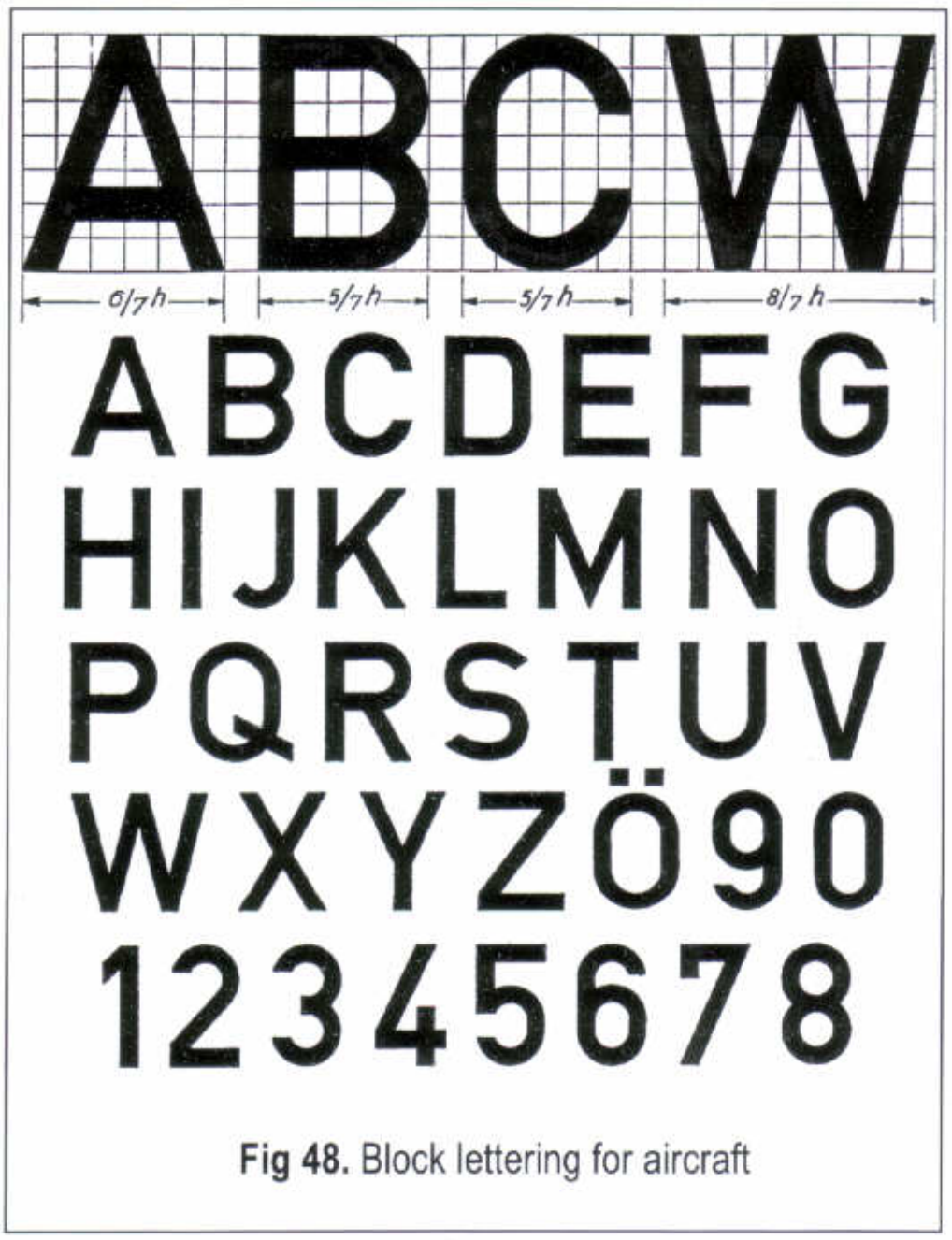


Fig 48. Block lettering for aircraft

2. Markings of Civil Aircraft
Example: D-ATUM

D = National marking of Germany
A = Code letter for the weight class to which the aircraft belongs. Also indicates number of people and pilot's licence classification.
ATUM = Registration marking, important for the air police.

The national marking is separated by a hyphen from the registration code. On German aircraft the registration code must always consist of four letters.

3. Swastika on Vertical Tail Surface
All Luftwaffe aircraft carry the swastika as the national marking. It is positioned on the tail fin, in the case of twin tail units always on the two outer surfaces.

272

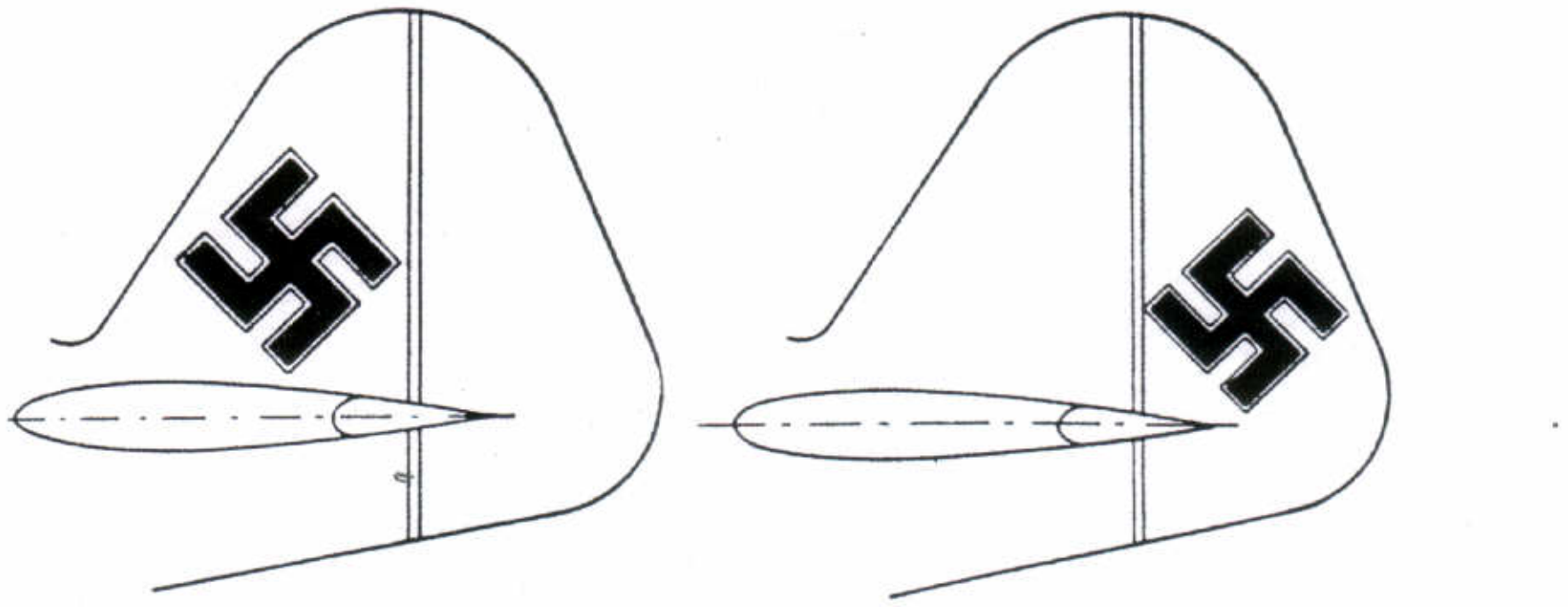
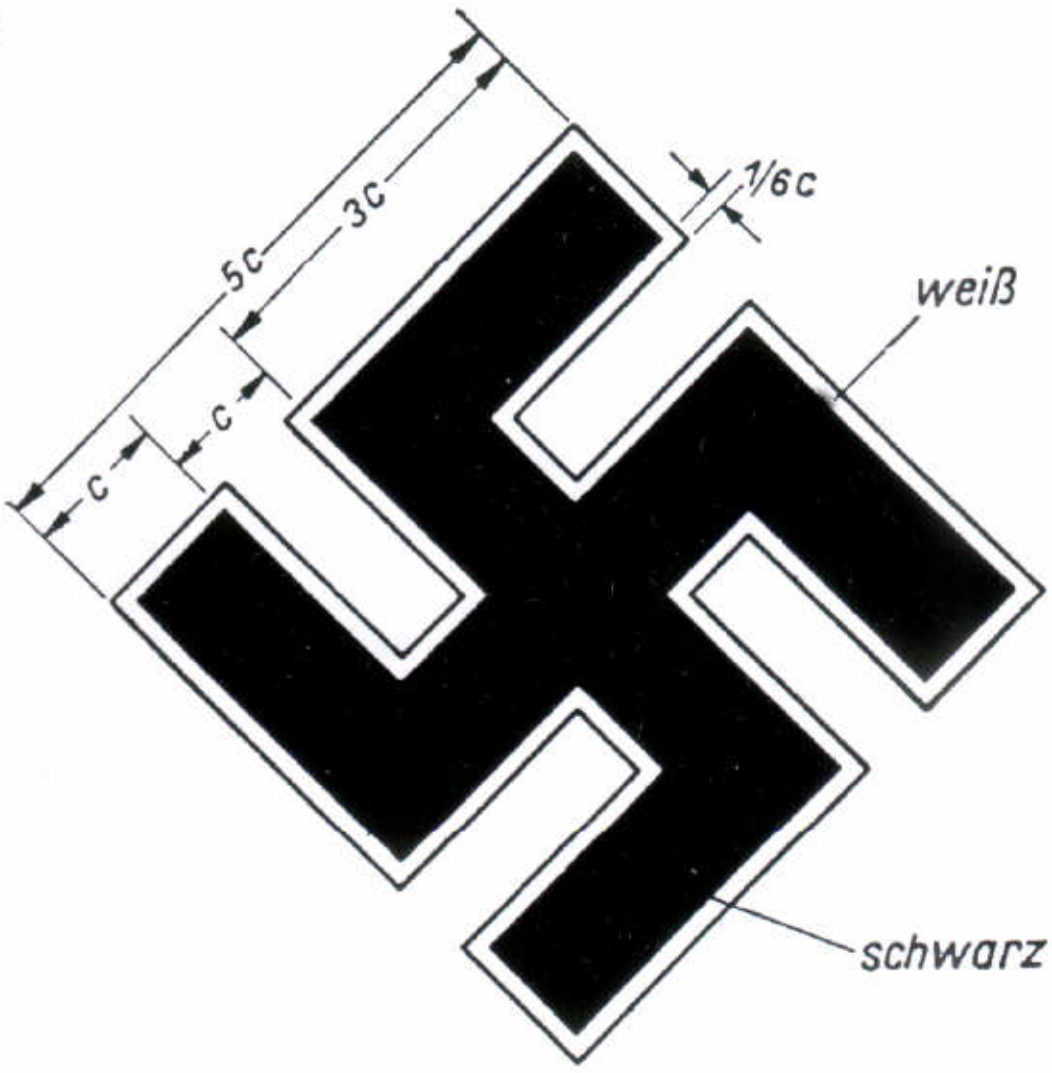


Fig. 49 Swastika on vertical tail surface

"The Swastika is marked out with a white and black contour (size as on the drawing below).
The lower limb of the swastika lies at a diagonal angle of 45°. The limb closest to the leading edge of the tail-fin is open upwards.
The size of the whole cross is at least one quarter of that of the tail-fin above the elevator. The swastika will be developed from a square of 25 equal squares. 1/5 of the side of the square produces the thickness of the cross.
1/6 of the thickness of the cross is the white contour and 1/4 of the white contour is the external black edging. Both contours lie outside the swastika."

273



Size Dimensions

Abmessungen

Größe 5c	315	(400)	500	(630)	800	
c	63	80	100	126	160	
3c	189	240	300	378	480	
1/6c	10	13	17	21	27	

Auf Sichtschutzanstrich Farbton 70÷75 fällt schwarzes Innenteil des Hakenkreuzes fort.

The black inner part of the swastika is omitted with camouflage paint 70 + 75

Fig. 50 Size ratios of the swastika

The Balkenkreuz* on the fuselage and wings
On military aircraft:
1. On the upper side of the flying surface, from the tip to the centre of the cross a distance of 2m. Largest dimension 1m.

2. On the underside of the flying surfaces, for biplanes on the underside of the bottom flying surfaces at the centre between fuselage and wing tip. With multi-engined aircraft, at the centre of the external engine to the wing tip. Maximum size 2 m.

3. The Balkenkreuz on the fuselage extends to its full height. For an aircraft with curved fuselage, the height of the Balkenkreuz is 1/4 of the circumference of the fuselage in each case, maximum 2m."

**Literally 'Bar' or 'Beam' Cross*

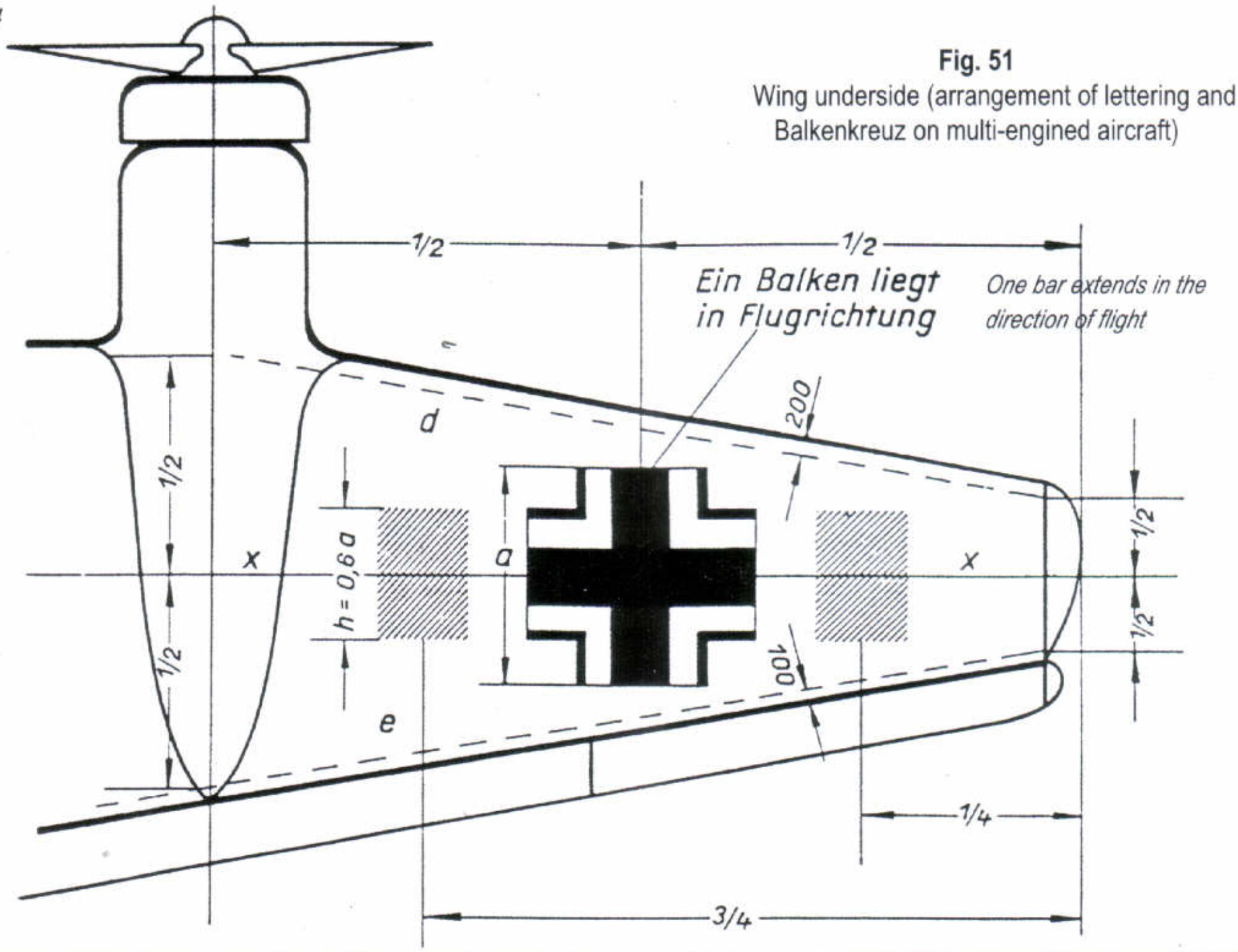


Fig. 51
Wing underside (arrangement of lettering and Balkenkreuz on multi-engined aircraft)

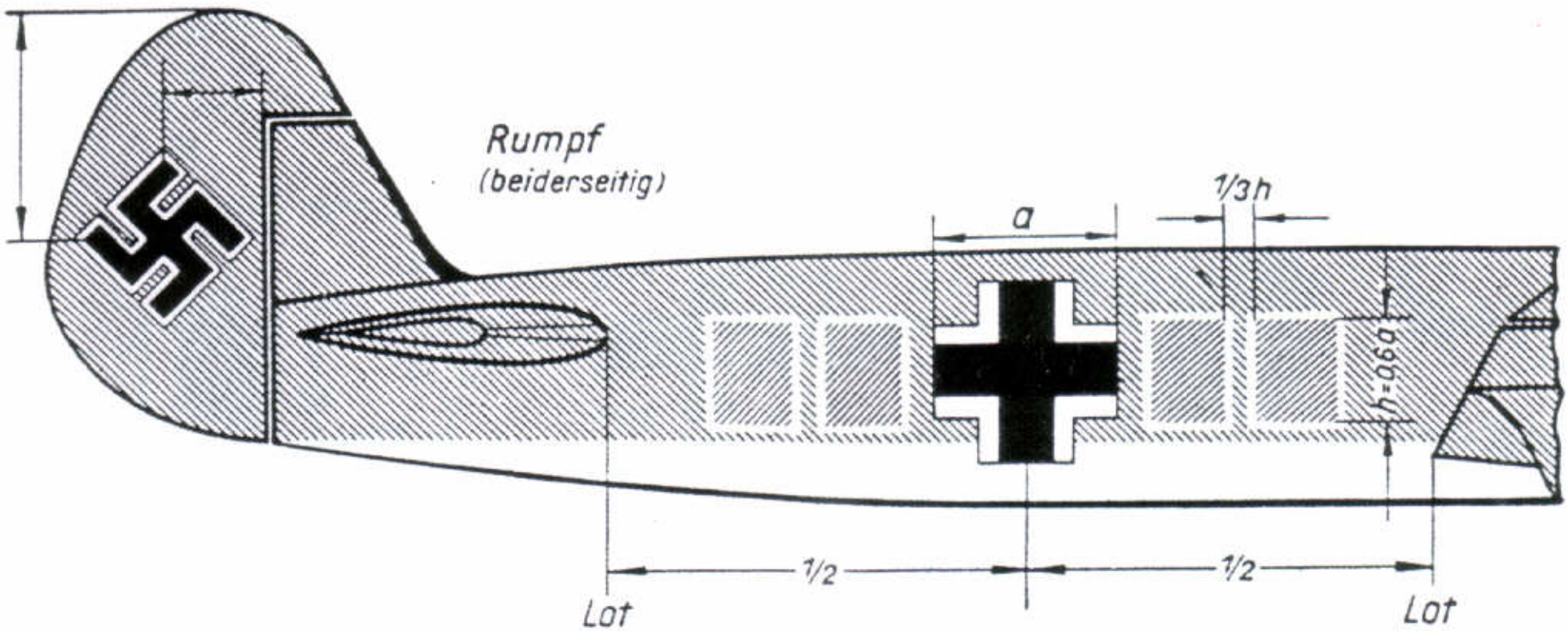


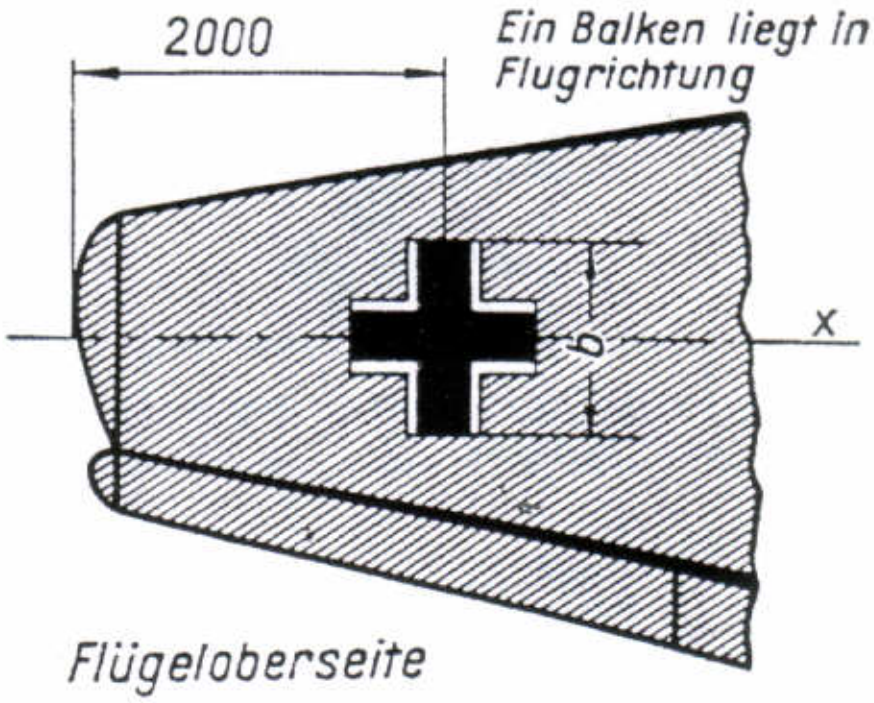
Fig. 52 Both sides of fuselage on military and frontline aircraft

"**For frontline aircraft:**

1. On the upper side of the wing, for biplanes on the upper side of the upper flying surface as described under 1.

2. The Balkenkreuz beneath the wings lies at the centre between fuselage and wing tip.

3. On aircraft used at the front, the Balkenkreuz on the fuselage is as already described in item 3. It is placed at the centre of the fuselage on both sides between the end frame of the wing and the foremost edge of the tail-fin.



One bar in the direction of flight

Flügeloberseite

Der Mittelpunkt des Balkenkreuzes auf Flügeloberseite liegt auf der festgelegten Mittellinie X 2000mm vom Flügelende entfernt.

Wing uppersurface
The centre point of the Balkenkreuz on the uppersurface of the wing lies on the ascertained centre line x 2000 mm from the wing tip

Fig. 53 Wing surface for frontline aircraft

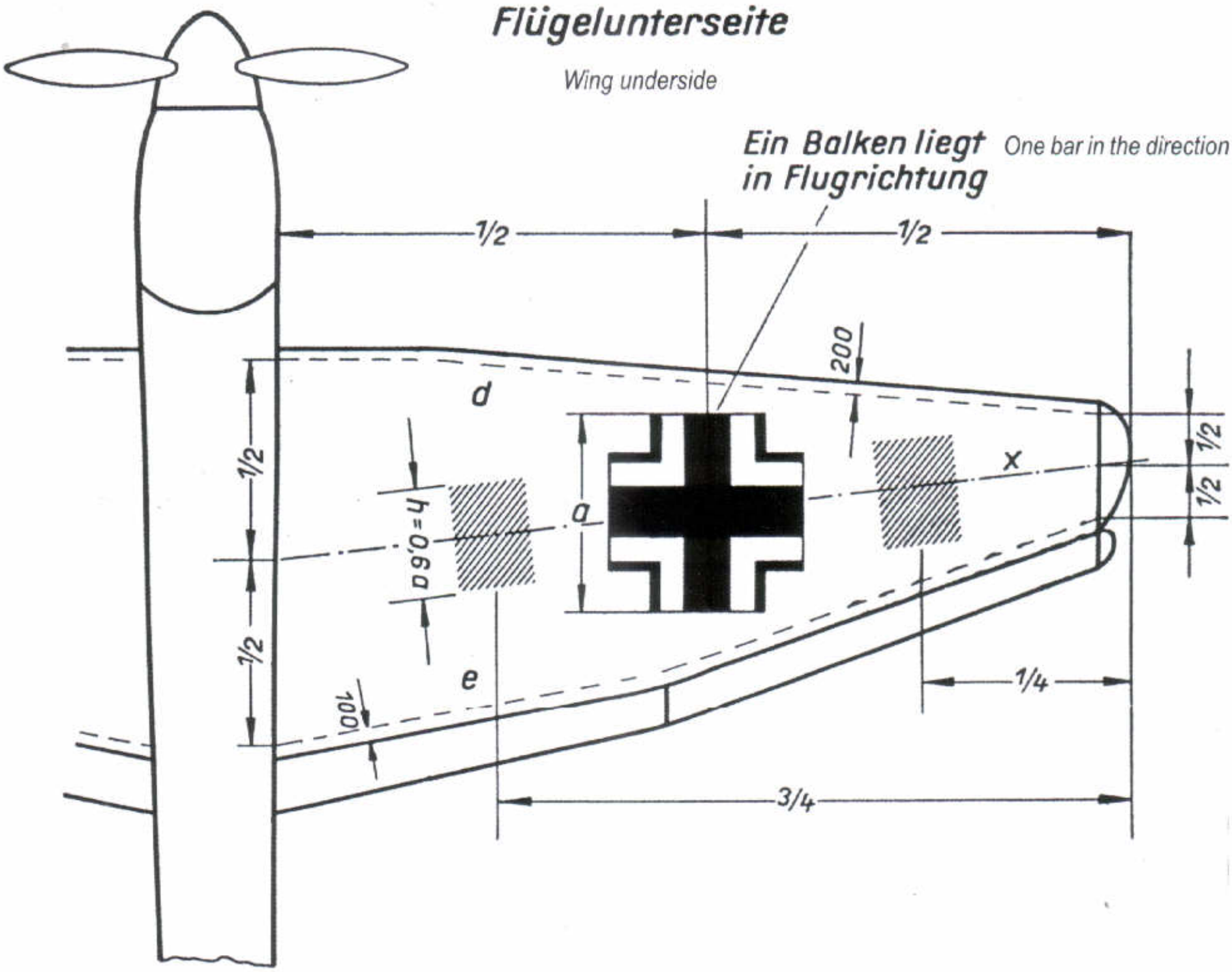


Fig. 54 Underside of wing
(Arrangement of lettering and Balkenkreuz for single-engined aircraft)

"**General for all military aircraft:**
1. One bar of the cross is always in the direction of flight on and beneath the wings and also on the fuselage. The cross is coloured black and accompanied with a strong white line.

2. The dimensions of the Balkenkreuz on the fuselage and beneath the wings are as follows:
1/4 of the length = thickness of the black cross
1/8 of the length = thickness of the white line
1/32 of the length = thickness of the black contour

3. The white stripe on Balkenkreuz on the wings is narrower. The dimensions are as follows:
1/4 of the length = thickness of the black cross
1/20 of the length = thickness of the white stripe
1/32 of the length = thickness of the black contour

In order to save labour, new aircraft and the like whose paintwork is renovated in a repair shop will receive simplified national markings on the wing surfaces, fuselage and tail.

The Balkenkreuz on the underside of the wing remain unchanged in all circumstances!

The national markings applied to the dark camouflage tones (shades 70 and 71 for land-based aircraft, 72 and 73 for naval aircraft, and 74 and 75 for fighters) will be simplified, the following being omitted:

4a. The black outer border of the Balkenkreuz

4b. The black centre of the national marking; if the fuselage Balkenkreuz is positioned partly on the light camouflage shade 65 or 76, the dark shade (70 to 75) should be extended within the white angles where these are located on the light shade.

4c. The black border of the swastika on the vertical tail surface, irrespective of the colour of the background (see TAGL Codes: 1 P 10 g, No. 37/42).

4d. Wing markings, such as letters and numbers, are deleted from operational and front-line aircraft. On the underside of the wings of front-line aircraft the third letter is positioned midway between Balkenkreuz and wingtip. On military aircraft all four code characters are to be carried on the underside of the wings.

Balkenkreuz on wing uppersurface

Balkenkreuz auf Flügel-oberseite

Balkenkreuz on underside of wing and on fuselage

Balkenkreuz auf Flügelunterseite und Rumpf

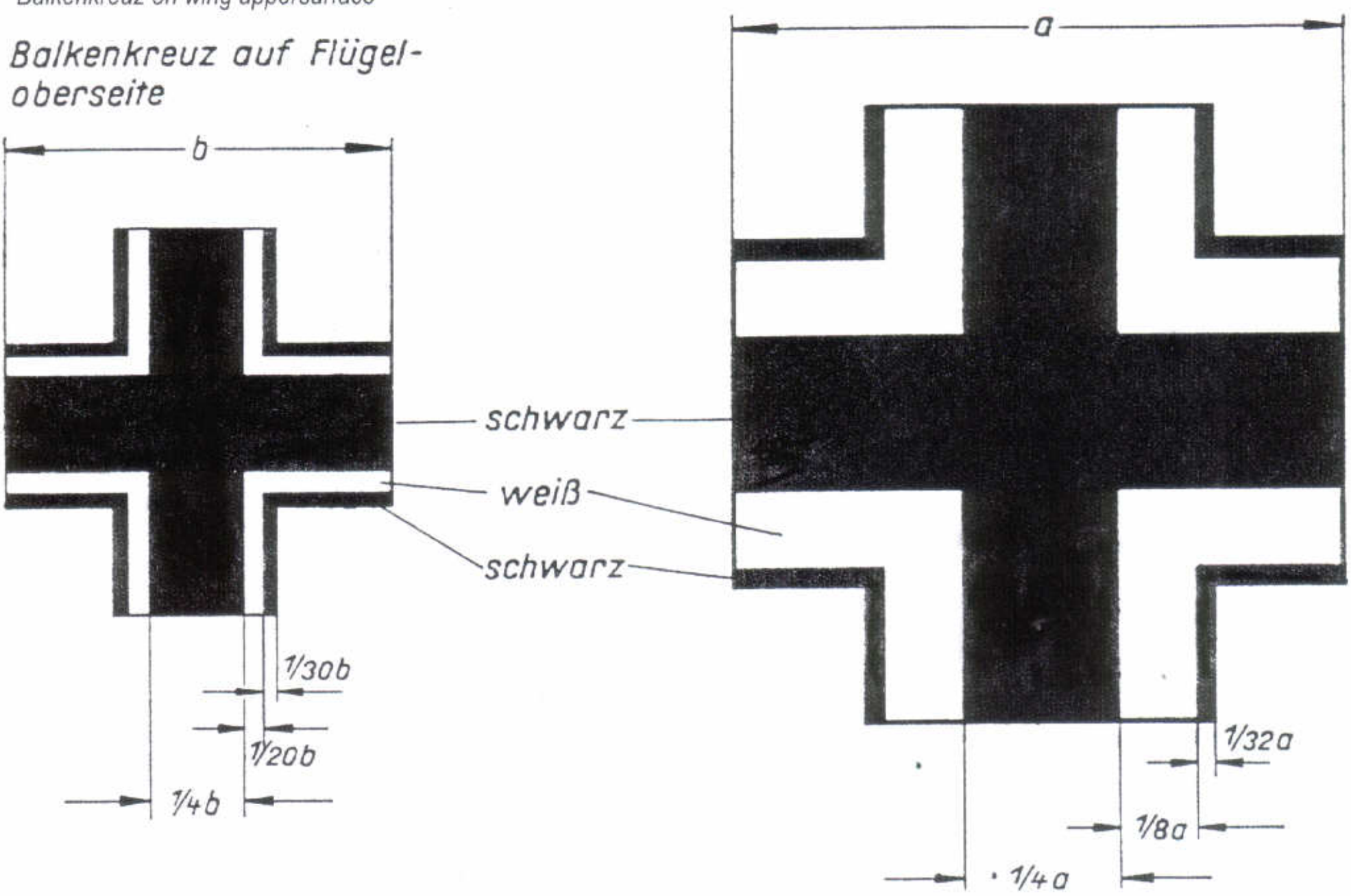


Fig. 55 Dimensions of the Balkenkreuz

As indicated above, there were two variants of Hakenkreuz (literally 'hooked cross'—swastika) and Balkenkreuz. A further simplification was introduced in *Sammelmitteilung* 2 of 15 August 1944.

"**National markings**
It is evident that despite various orders concerning simplifications, savings, etc. the cross and swastika are still being applied in their original form. For the Balkenkreuz only the angle and for swastikas either the black part or only the white edging need be painted. On the bright shades 76 and 21 only the black angles of the Balkenkreuz and black swastika, and on the dark shades 72,73, 75, 81, 82 and 83, only the white angles of the Balkenkreuz and the white edging of the swastika.

This regulation also applies to the use of stencils or transfers, where stocks will of course be used up. Future orders will however, be made as above. Shade 77 grey will be substituted for shade 21 for the angles and edging on night camouflage in shade 22 (see L.Dv 521/1 p. 18).
Economy officers' attention will be drawn to this notice."

The above excerpt from the *Sammelmitteilung* is particularly interesting because it shows the change in the general marking of the Luftwaffe's aircraft, from the very laboriously produced white stripes executed with black edges to no more than rudimentary markings by the last months of the war.

DIMENSIONS OF NATIONAL INSIGNIA

These sizes, in mm, are extracted from various Aircraft Handbooks and factory drawings. The list of types is not exhaustive, nor does it show all variations for a type. Reference should be made to photographs for these. Dimensions with a question mark are estimated as they are not specified on the original drawings. Later sizes are shown after the /

Type	Above wing	Below wing	Fuselage	Swastika
Do 217E	1000	1750	1250	420
Fw 190	910	900/910	800/810	540/530/480
He 111	1000	2000	1800/1400	710/650
He 177	1000/900	1900	1600/1500	1086/900
He 219	630	1000	1000	420?
Hs 129	1000	1200	1000	420
Ju 88	1000	1400?	1000?	650
Bf 108	900	800/750	800	300
Bf 109G	1000	950	950	315
Bf 110	1000	1200	1000	500
Me 262	630	800	800	430

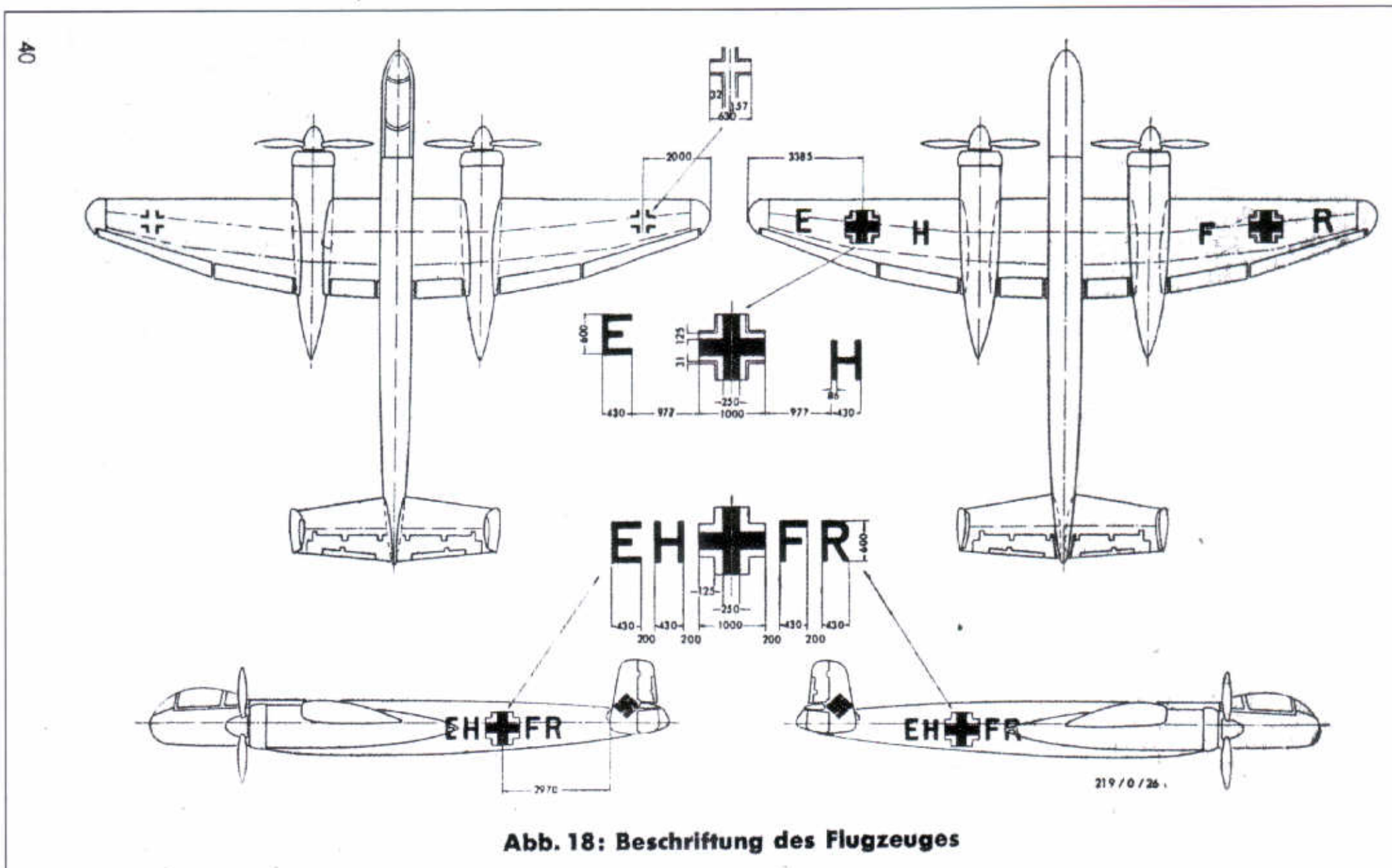


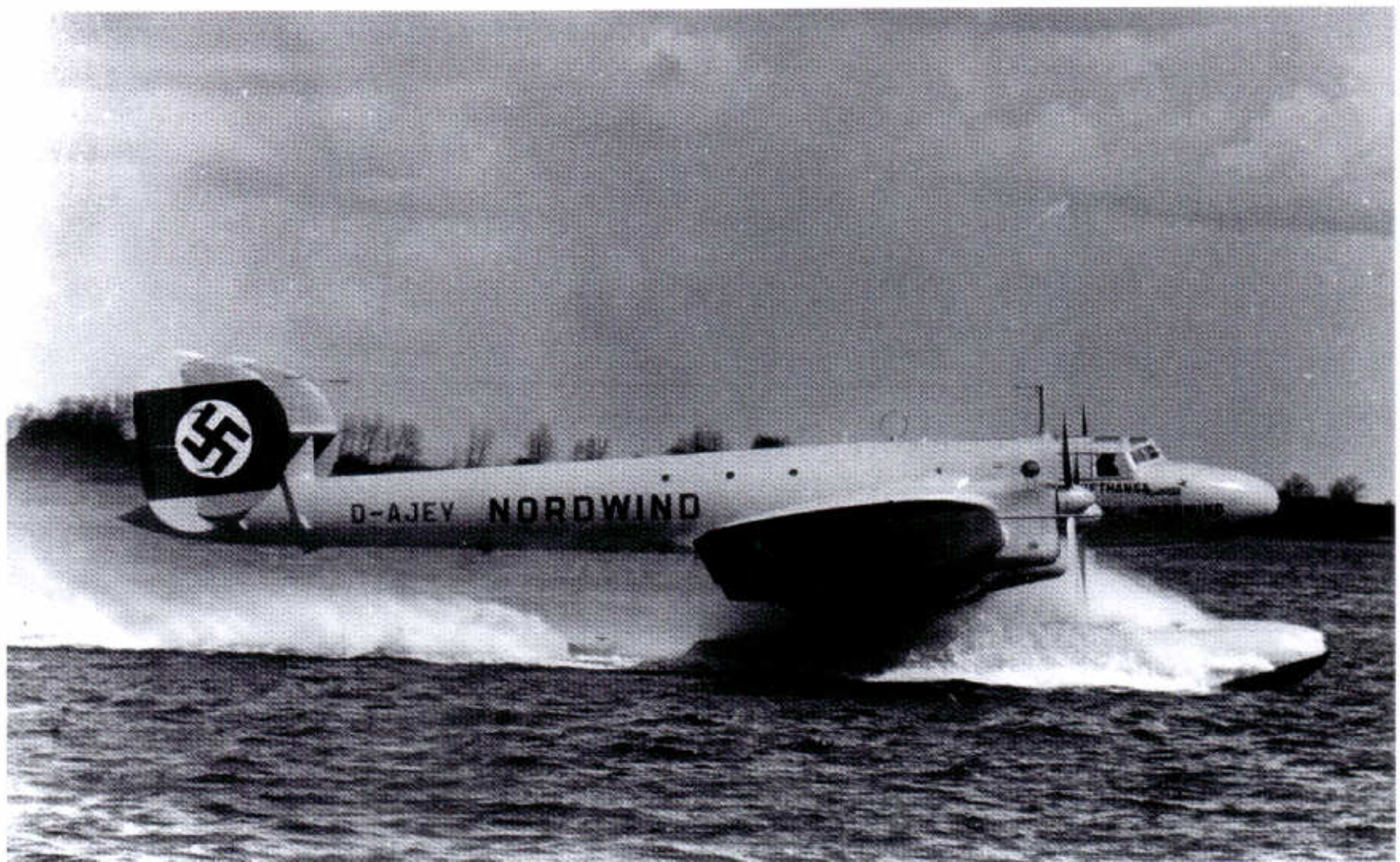
Abb. 18: Beschriftung des Flugzeuges

280: *Staff from the E-Stelle Travemünde in front of the Heinkel He 60B prototype, D-2325, in early 1933. The aircraft appears to be in an overall light grey finish, possibly from the Avio-norm range by Lüdicke and Co, whose paints were favoured by Heinkel. The letter-number combination on the fuselage and rudder are the only markings. Such markings were to be phased out about a year later, the last known number being D-3466. In the background is D-2215, the He 59b prototype, in silver finish*

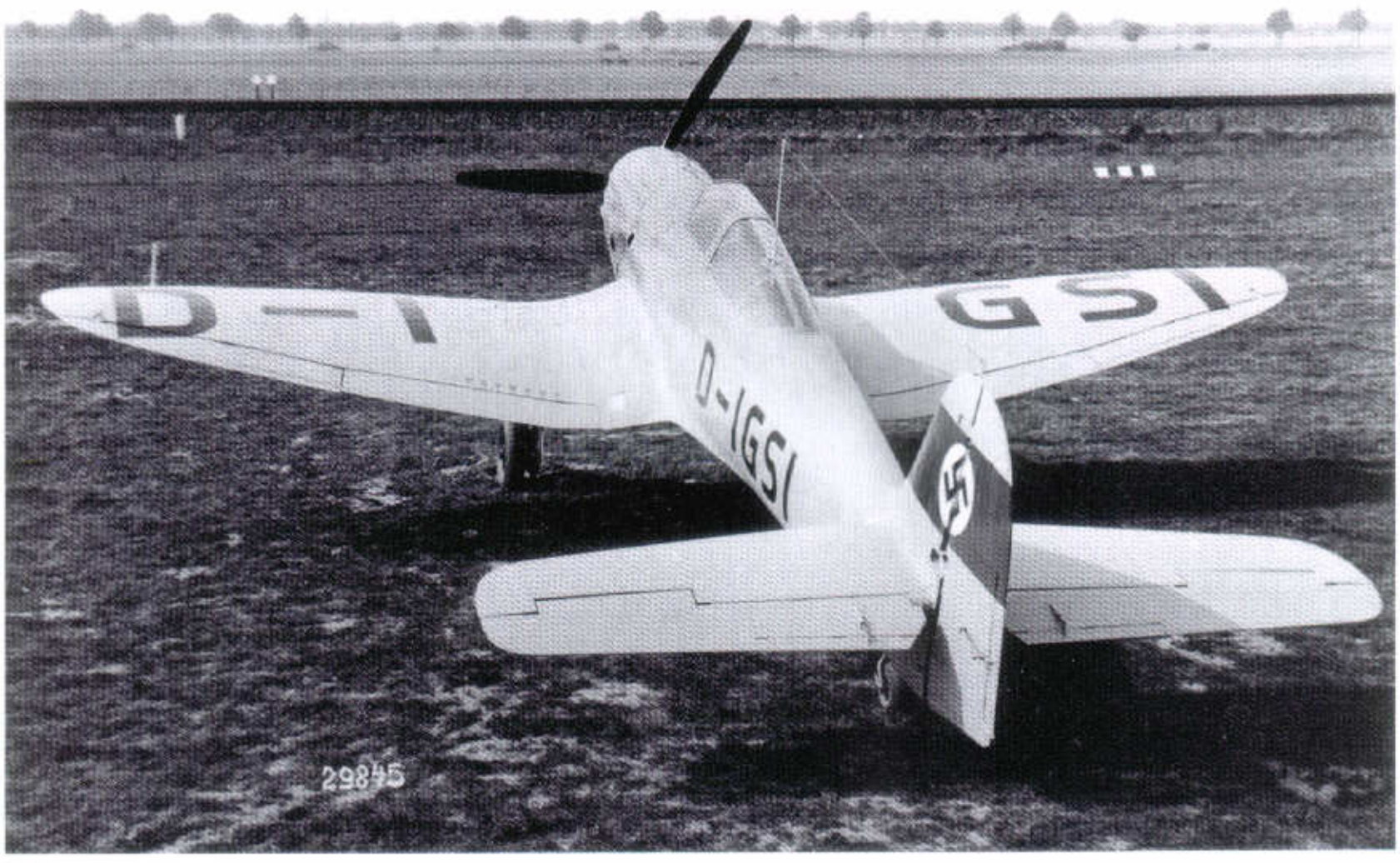
281: *Curious onlookers gather around the little-known Gerner G IIRc which wears the standard tail markings as required between 6 July 1933 and 15 September 1935 when the swastika marking replaced the black, white, red stripes (from top) on the starboard side of the fin. The registration follows the regulations exactly. The emblem under the cockpit is that of the Adler company which took over the Gerner firm. Overall finish appears to be a light gray*

279 Left: *This diagram from the Heinkel He 219A-0 handbook, Part 0, from January 1944, defines the position and dimensions of the national markings and Stammkennzeichen. Note that these are not the simplified style*

282 Right: *Just about at the point of taking off, this is the Blohm & Voss Ha 139V-2, D-AJEY,* Nordwind, *in Lufthansa markings. National markings and registration are all standard for the period (1937). In this picture the rudders have been modified to the style used by the Ha 139B. Refer to page 21 for colour scheme details*



283: *The Focke-Wulf Fw 56V-2 wears the standard civilian markings of early 1934, shortly after letter registrations had come into effect. At this time the swastika was only applied to the port side of the fin and rudder. Note the data table under the tail strut giving details of weights and limitations. Finished in overall silver, the aircraft had a vaned propeller spinner fitted in connection with dive-bombing trials*



284: *A factory photo showing the Heinkel He 112V-9, D-IGSI, the first true prototype for the He 112B. All markings are as required for civilian aircraft in 1937, the aircraft still belonging to the manufacturer at that time. Finish is an overall light grey, probably L40/52. Ultimately the aircraft was sold to the Hungarian government*

285: *With effect from 1 January 1939, all Luftwaffe aircraft which were not in front line service but were on the strength of training schools and the like (see page 150) were to carry a civilian registration with a 'WL' (WehrmachtLuft) prefix. These remained in use until about March 1940. This Hs 123A is obviously in use with a training school as it is coded WL-IELH. Camouflage is the 61/62/63/65 scheme. Note the swastika has been modified in accordance with the instructions issued in January 1939 (see page 150) by having the red band over-sprayed*

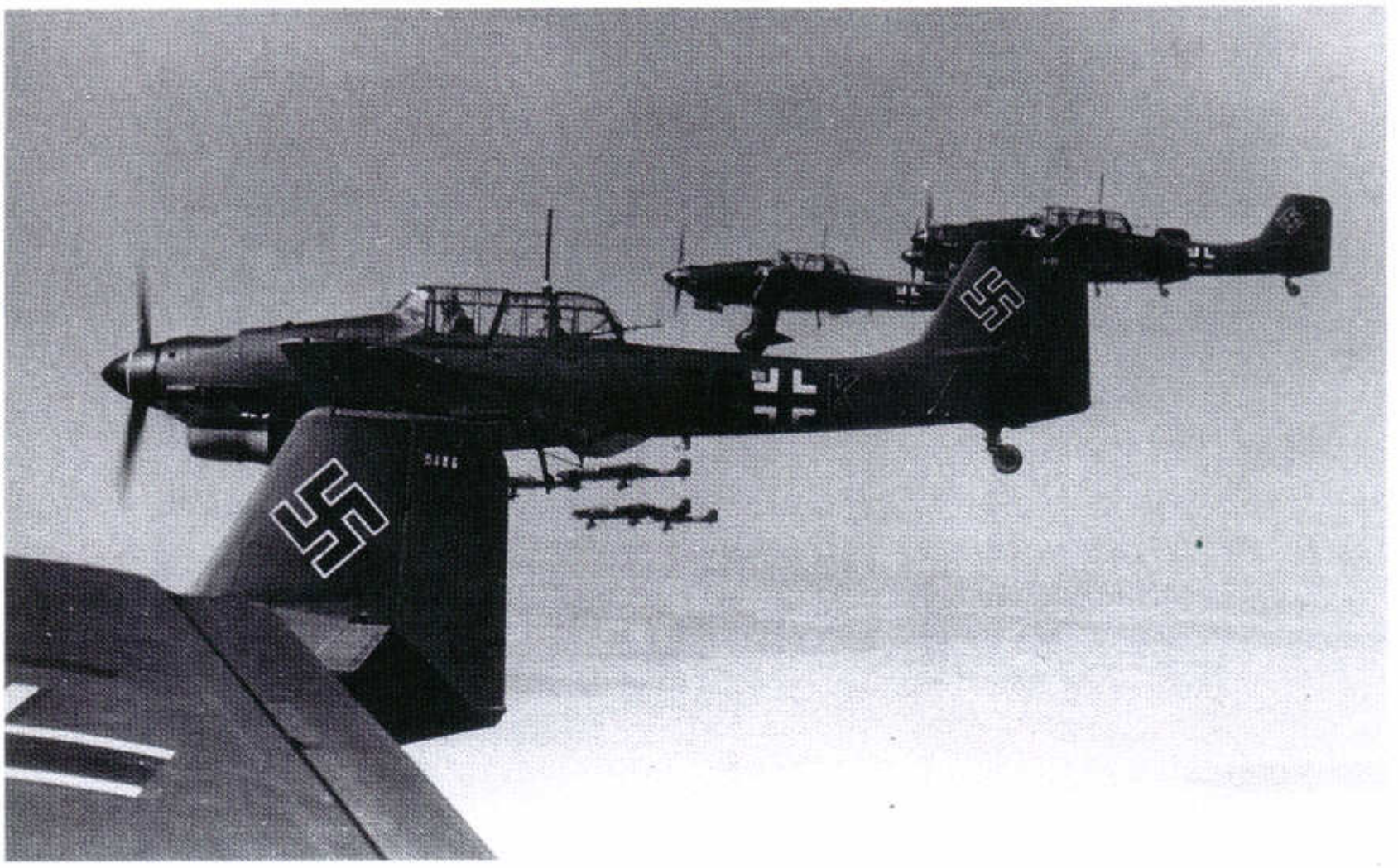
286: *The requirement for training aircraft in Luftwaffe service to carry the both the 'WL' prefix and a fusealge Balkenkreuz led to some unusual arrangements to accommodate both markings. This silver-finished Focke-Wulf Fw 44C, WL-EIPQ, carries the narrow-style cross where a hyphen had previously been. Apart from the fact that the picture was probably taken sometime in 1939, nothing else is known of the aircraft*

287: *A Bf 109D, 'Red 3', WNr 2876, of ZG 52 in Germany in September 1939. Finished in 70/71/65, the aircraft has a pre-war style Balkenkreuz. The swastika is also in the pre-war position in the middle of the fin which shows signs of overpainting. This is probably the result of the overpainting of the white disk and the red strip in accordance with the order dated 01 January 1939.* *(See page 150)*

288: *On 18 October 1939 blocks of four-letter combinations known as 'Stammkennzeichen' were first issued to Luftwaffe aircraft in use on second-line duties or before issue to a front-line unit. This Arado Ar 66, RT+NX, belonged to an unidentified A/B school somewhere in southern Germany. Apparently overall RLM 02, note how the markings on the fuselage have been painted over an earlier larger marking in a lighter grey. The code letters have also been painted on the upper wing surface, contrary to regulations (AMC)*

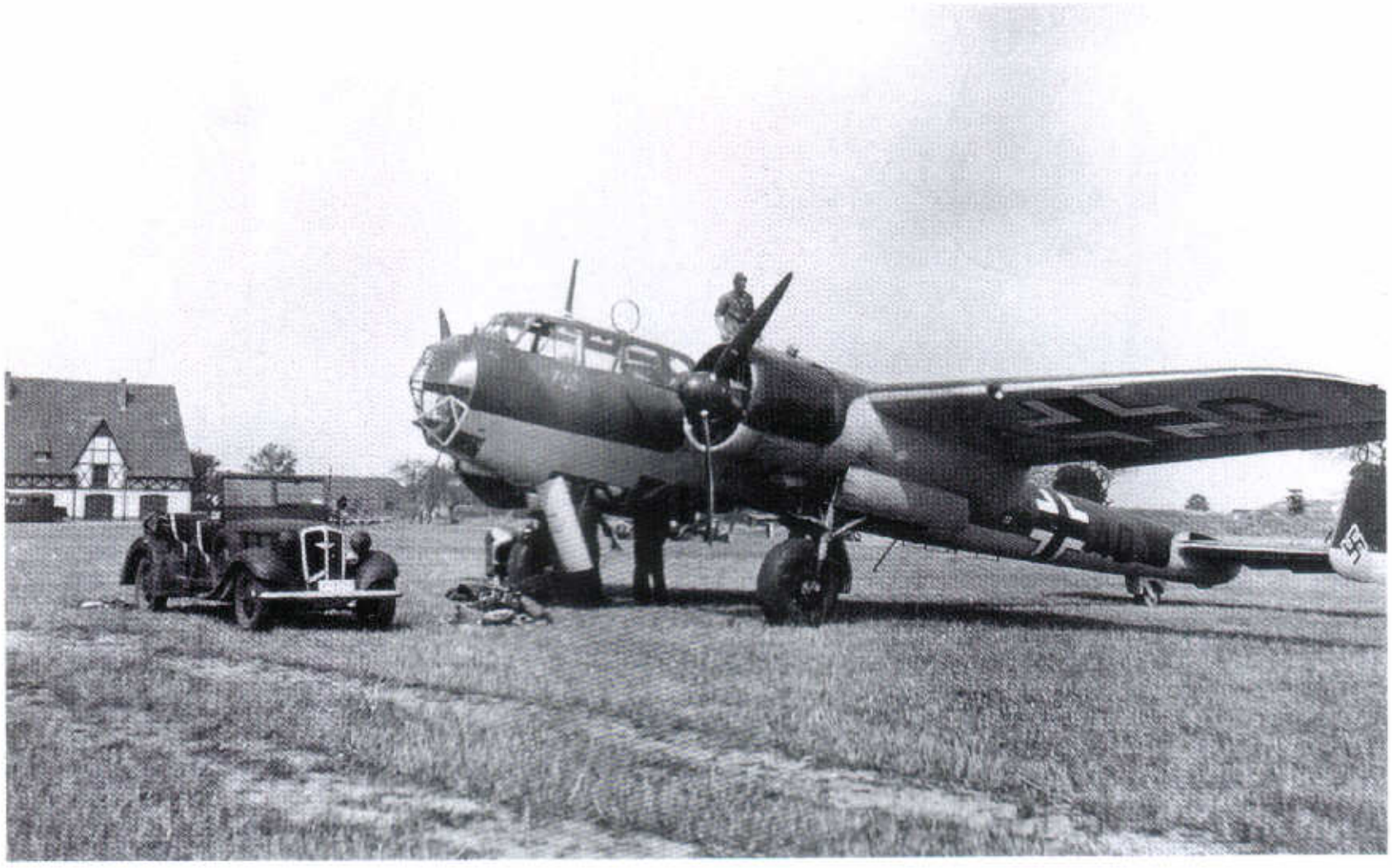
289: *This Heinkel He 70, possibly WNr 1774, of FFS E A/B Quackenbruck, wears the early style of training codes found in the immediate pre-war years but in white, not black. The black-painted underside to the wing carries an enormous Balkenkreuz and the code, S4+Q22, in white again. The glossier finish of the 7160 lacquers used for the national insignia is clearly visible*

290: *A Focke-Wulf Fw 58, KY+NF, belonging to KFS Thorn in late 1940. Finished in overall RLM Grau 02, it wears a Balkenkreuz in the 'early-war' style, applied to the full height of the fuselage as required. The marks just behind the nose glazing are primer paint after small repairs (AMC)*



291: *Ju 87B-2s of 5./St.G.2 on a training flight over their home base at Bonn-Hangelar in winter 1939-40 show the then-current markings style for front line bomber aircraft. Nearest is the tail of T6+GN, WNr 5486. Next is T6+KN, WNr 5435. The very low contrast between the RLM 70 and 71 used on the upper surfaces and the black codes has resulted in a white outline being applied to the individual aircraft letter, this letter also being painted in black above and below both wing tips at this period of the war. The propeller spinner tip appears to be gloss black*

292: *An almost brand new Dornier Do 17Z, WNr 702, wearing a partially visible Stammkennzeichen, ?G+AQ. The markings are typical of a Luft-waffe aircraft immediately after it left the manufacturer. All national markings are standard for the early war period. Note the high demarcation line between upper and lower surface colours on the rudders. The car is an Adler civilian car modified with bucket seats for military use*

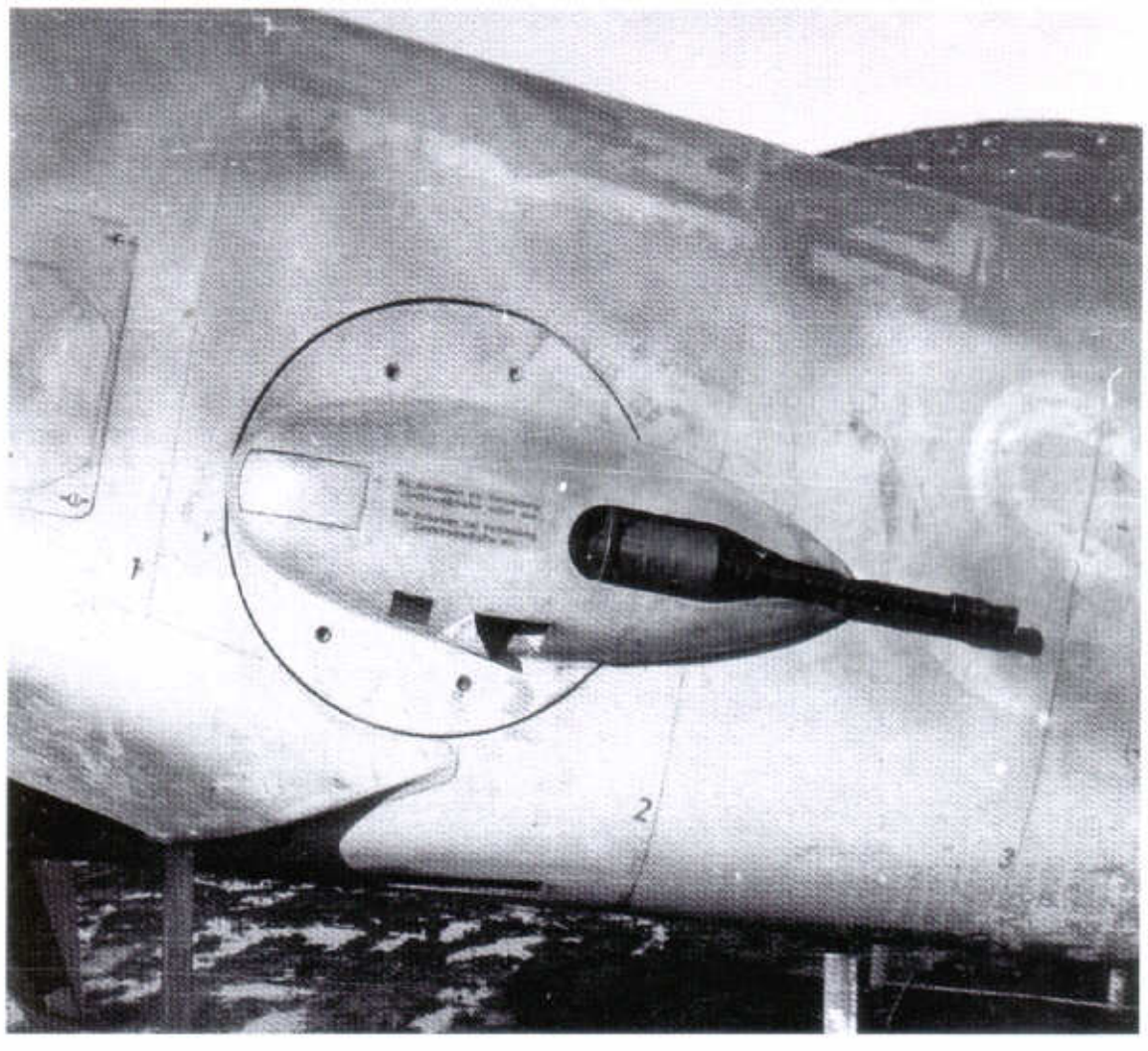


293: *This Bf 109E, 'Yellow 14' of II/JG 77 wears a peculiarly shaped '4' which was a hallmark of the unit in its previous incarnation as part of Trägergruppe 186. Overall finish is 70/71/65 with the Balkenkreuz in the 'early-war' style and an exceptionally large staffel emblem. Note the pilot is wearing a special white or yellow cover to his flying helmet, used by aircrew flying over the sea in the early part of the war, intended to assist in locating them should they be forced down into the water*

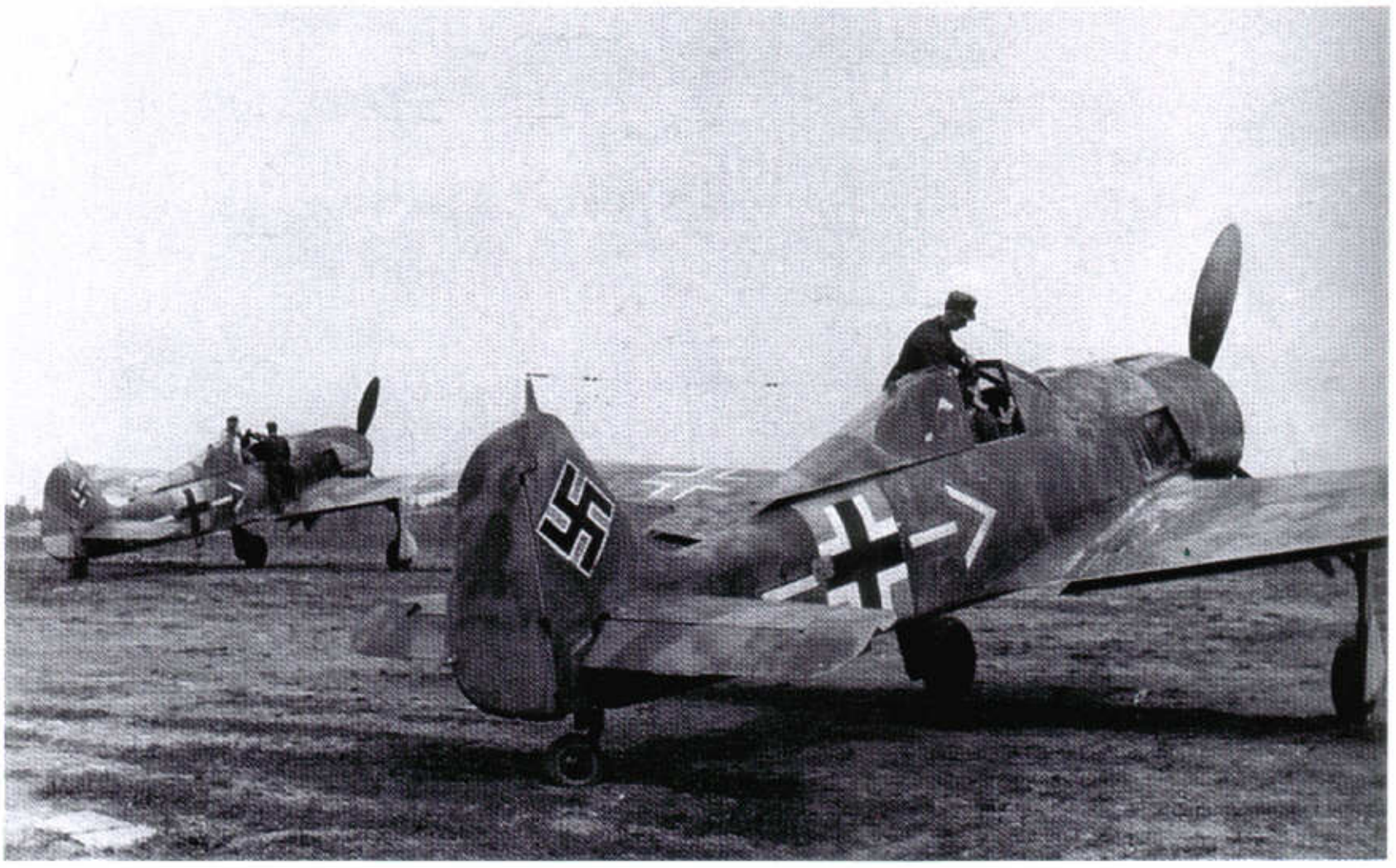
294 Right: *Adolf Galland and his Bf 109E, which is finished in 74/75/76. His commander's chevron is in accordance with the details on page 167. The aircraft also has both the JG 26 emblem and Galland's own Mickey Mouse badge. The head armour and the cockpit interior are all in 66 Schwarzgrau*

295 Far right: *This Bf 109E-1, 'Black 9', of 8./JG 2 in August 1940 has had a fuselage mottle in a dark tone applied by sponge. It also has a non-standard Balkenkreuze which has had an extra wide black outline added to reduce the white angles. Note the III Gruppe wavy band*

296: *A factory-fresh Fw 190A-4 wearing a typical Stammkennzeichen delivery code on its 74/75/76 camouflage. All markings are typical for a fighter aircraft produced in the first half of the war*



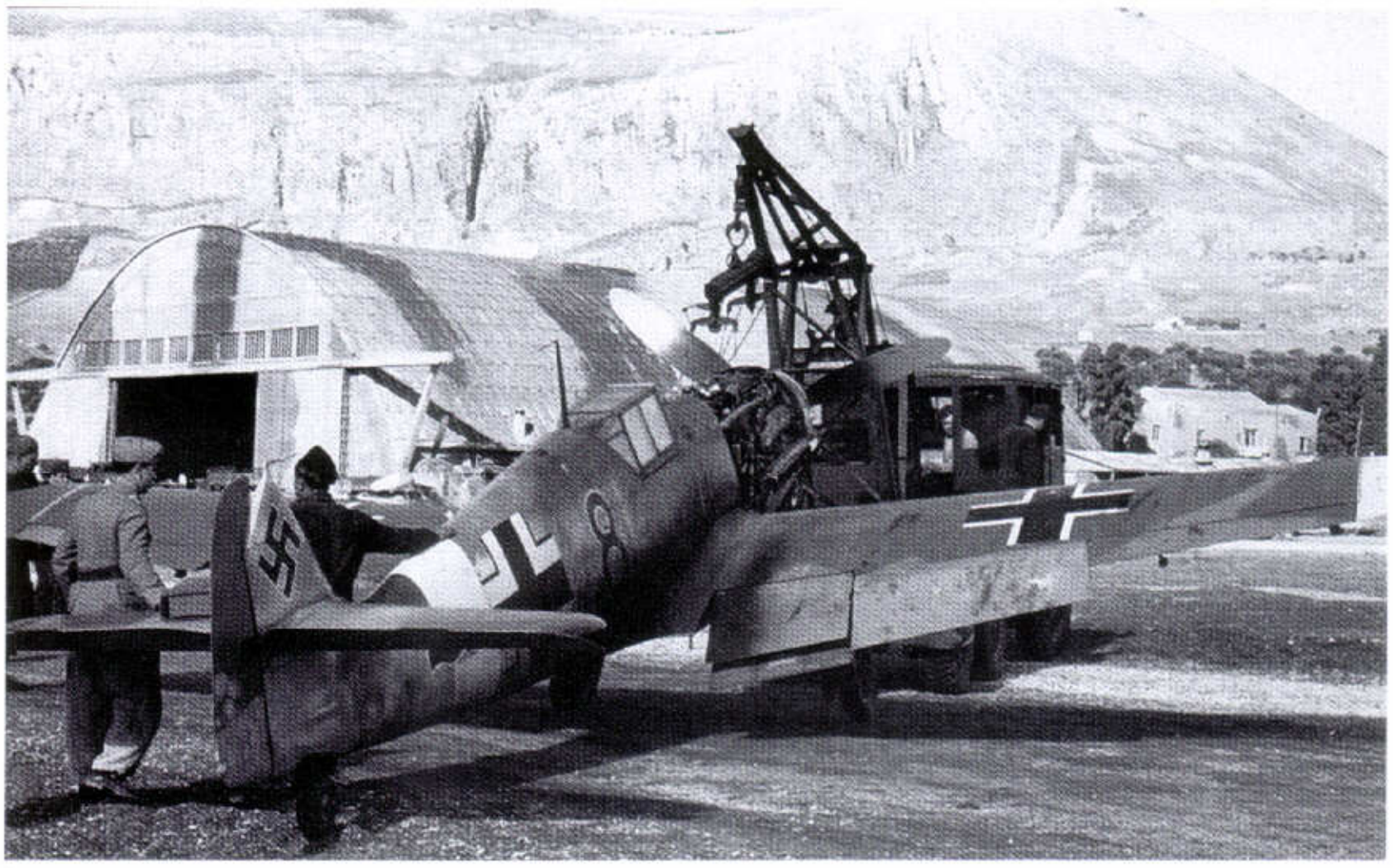
297: *A close view of the port fuselage barbette of Me 410A-3, WNr 10259, F6+OK, of 2.(F)/122, showing part of the delivery Stammkennzeichen which has not been fully washed off. Only the partial code 'SN+?M' is known, the third letter had been overpainted by a white theatre band, which in turn had been obscured by camouflage. Note the maintenance instructions stencilled in 25mm high letters on the gun fairing and the fuselage frame former numbers*



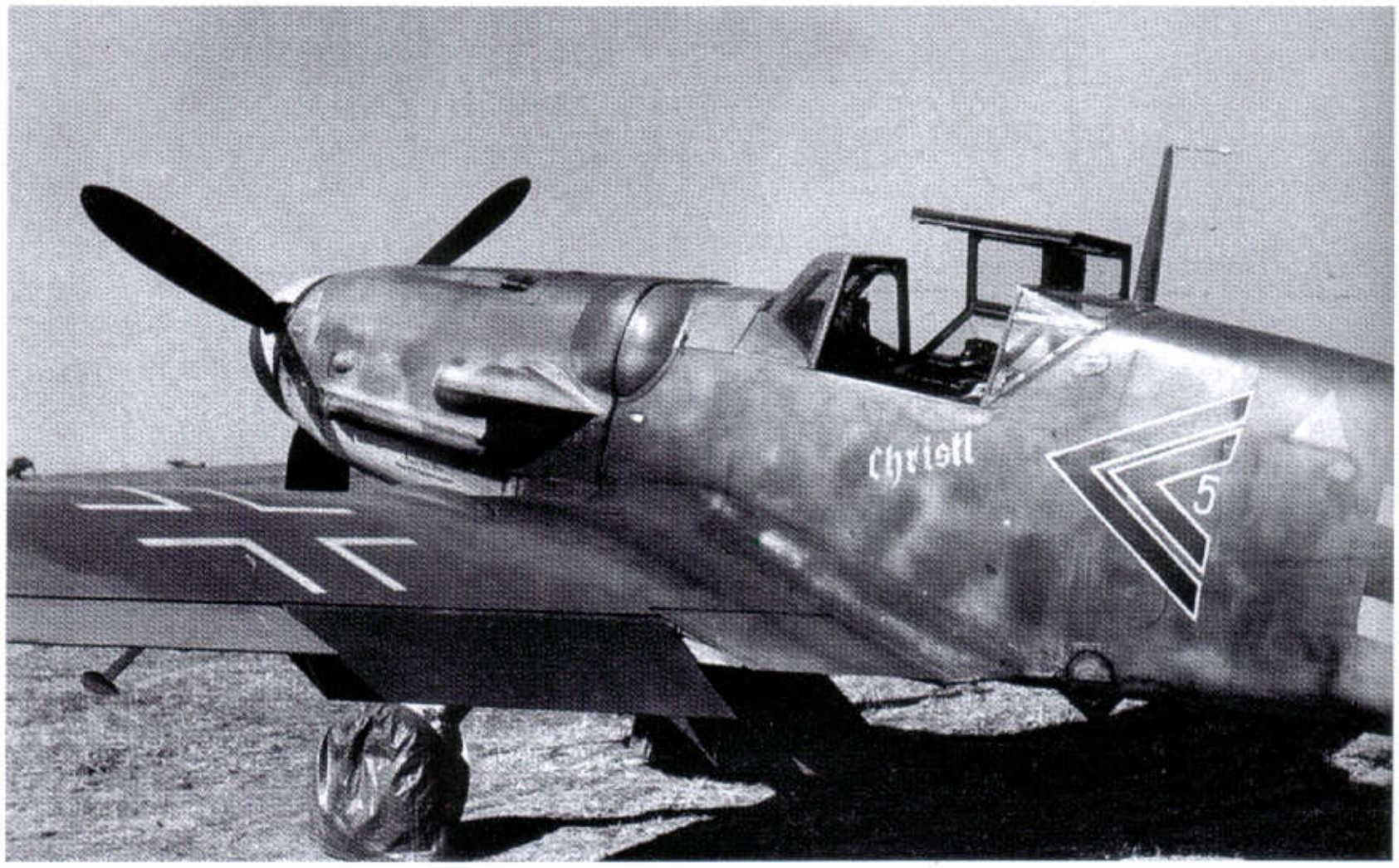
298: *Although these Fw 190As of JG 54 wear typically imaginative unit-applied camouflage, their markings are strictly in accordance with the regulations. Both wear the prescribed markings for the Geschwader Kommodore (see page 167) and standard 'early-war' style national markings, as well as yellow fuselage theatre markings. The fuselage Balkenkreuz is in typical Focke-Wulf style without the black outline*

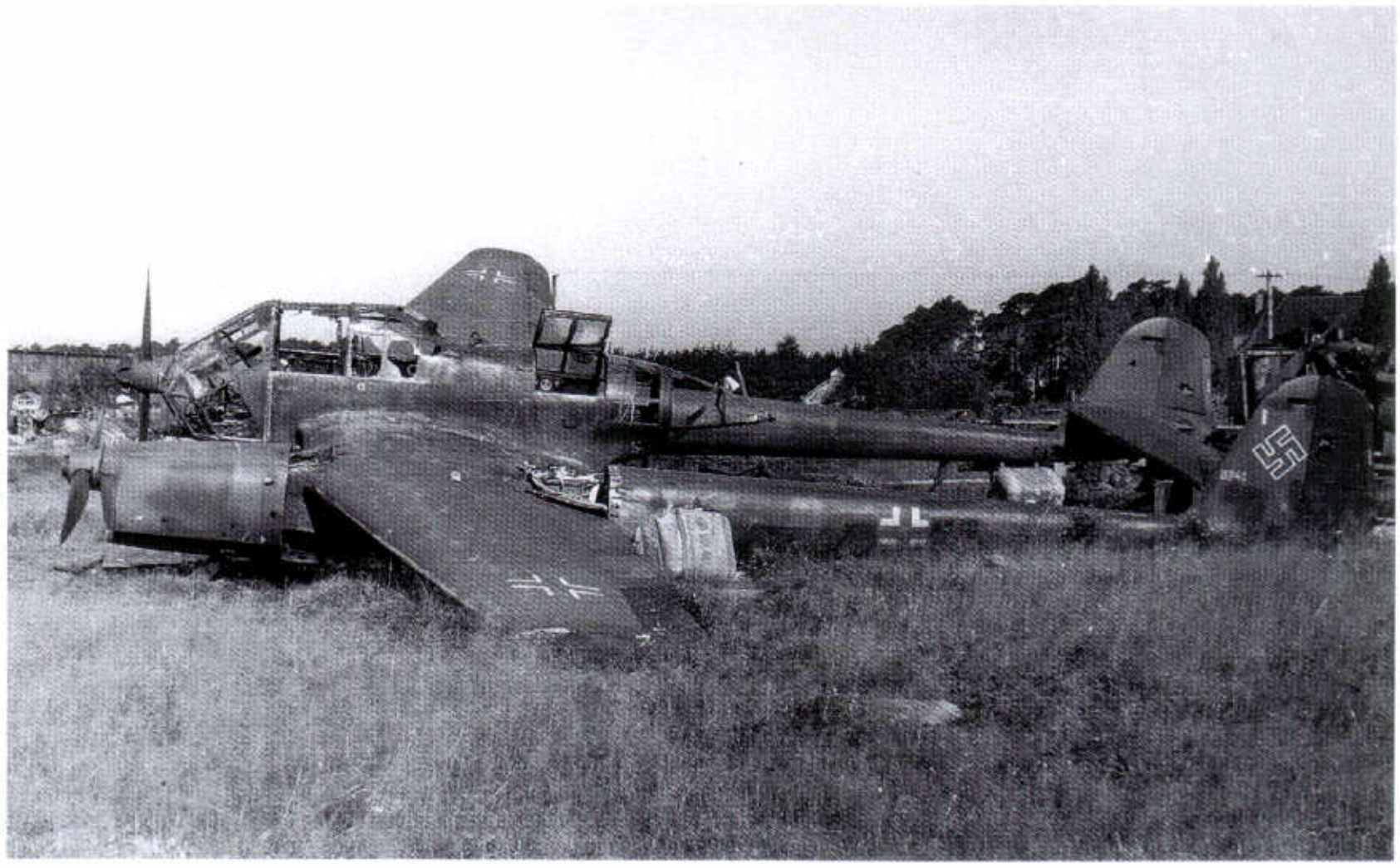
299: *This wrecked Junkers Ju 52 carrying the fuselage codes of 2./KGr.z.b.V.1 in North Africa wears standard markings for the time and theatre with an additional tactical marking on the rudder which indicates that it is actually from 7 Staffel of KGr.z.b.V. 400. These type of markings were unique to the transport units which were formed and reformed at short notice for operations anywhere the army required support. Camouflage appears to be overall 70*

300: *A Messerschmitt Bf 109G-2 of either III./JG 53 or 11./JG 26 under repair in Sicily in November 1942. Apart from the addition of partial white theatre markings to the fuselage and starboard wing tip, the aircraft is entirely finished in standard European markings and colours. Note how the abbreviated III Gruppe wavy band has been painted around. The 74/75/76 camouflage pattern has been extensively modified by the unit painters*



301: *Gerhard Barkhorn's Bf 109G-6 reveals a standard 74/75/76 camouflage scheme with the simplified style of crosses. A yellow theatre band can just be made out on the fuselage. The attractive double chevron served to identify the aircraft as that of the Kommandeur of I Gruppe of JG 52. It was not, however, the officially prescribed style (see page 167). Note the spinner in 70 with a portion in white and the small white number '5' in the chevron. 'Christl' was the name of the pilot's wife*



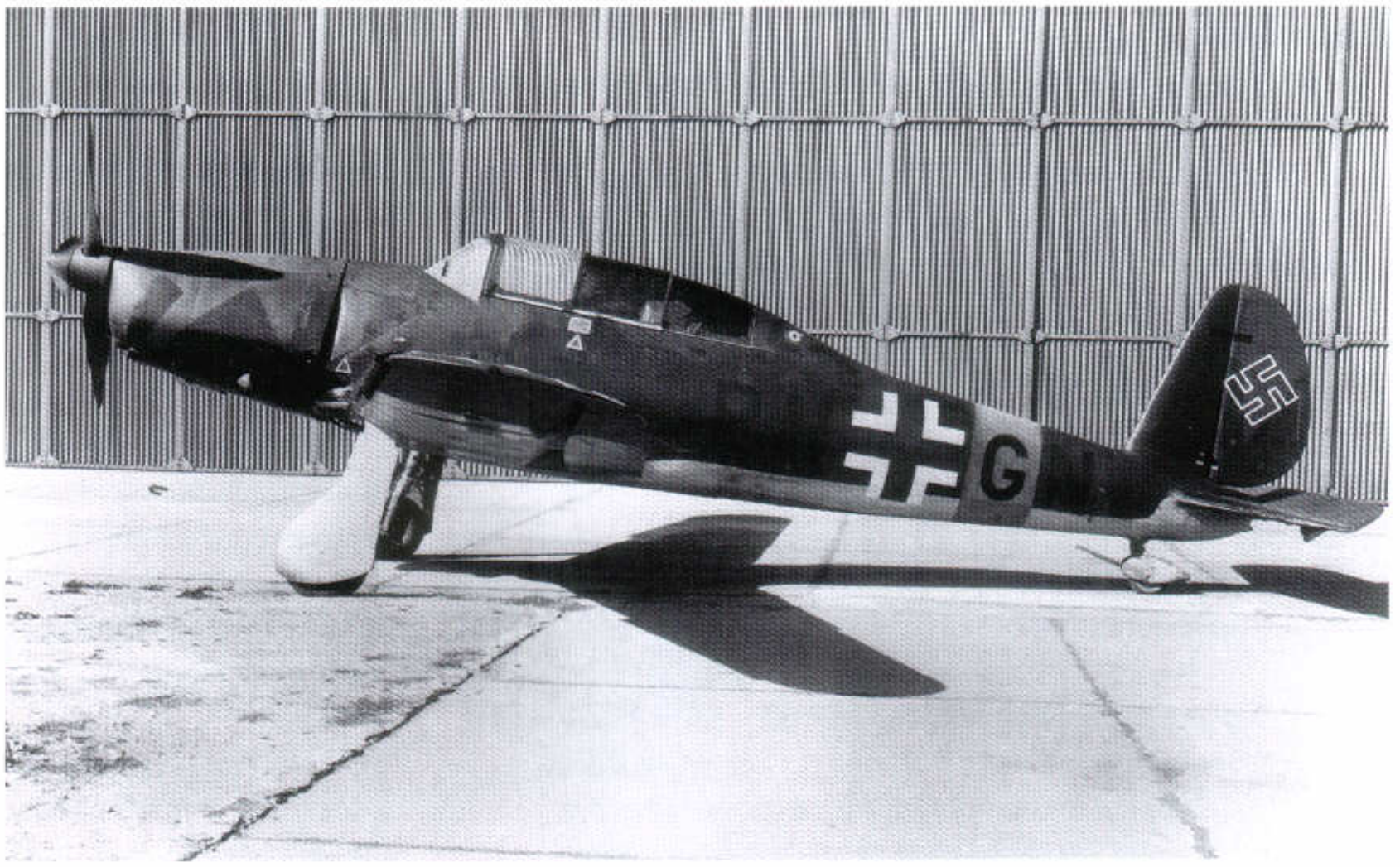


302: *Found abandoned at Berlin-Gatow in summer 1945, this Focke-Wulf Fw 189A, WNr 0241, (French-built?) is in standard 70/71 camouflage which has been overpainted in a darker tone where the unit codes, theatre bands and a unit emblem on the port engine cowling had been. All national insignia are of the correct white maximum simplified type*

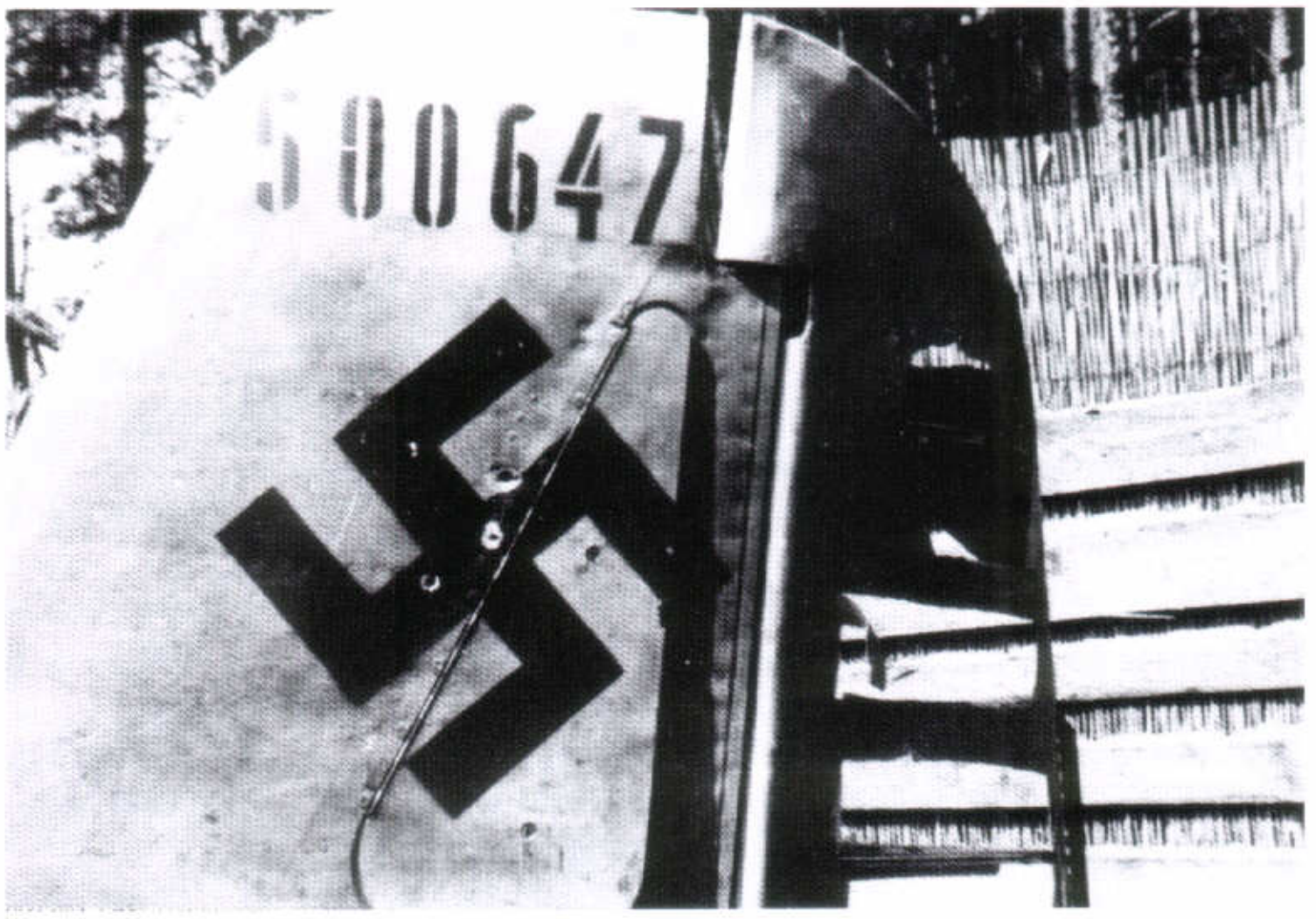
303 Left: *A well-worn Junkers W34. No colour demarcation is visible, therefore it is very likely that the aircraft was finished only in 71/65. Swastika and Balkenkreuz are the 'late' style noted on page 155, in white against the dark camouflage*

304 Below: *A new, early production Fw 190D-9, WNr 210051, in mid-1944. The underside 76 is very pale but the fuselage spine could be 74/75, possibly solid 74, or even one of the late greens. As required by regulations, all the national markings are in the simplified black against the light grey. Note the glossy spinner*

305: *Seen outside a hangar at Prague-Letňany, this Arado Ar 96B, PH+GN, wears standard 70/71/65 camouflage and the later simplified style of all-white national insignia on the uppersurfaces. The undersides carry the black/white Balkenkreuz and the full call-sign, as well as yellow wing tips. Non-standard darkened rear canopy glazing has been fitted*



306 Right: *A Ta 152 tail assembly fitted to an Fw 190D-9. WNr 500647, 'Brown 4', of JG 26 wears a stencil-style number which served as a call sign until delivery to a unit, as required by the order of 1 July 1944, detailed on page 173. Camouflage is a grey-green variant of 76, while the swastika is all-black*



307 Below: *These Ar 96s found at the end of the war all wear simplified late-war national markings over splinter camouflage of 70/71. (The second one back may be in 81/82). Most wear partial WNrs as well as unit codes as call signs. '753' has both German and Hungarian markings*

Other Markings

"**Marking of completely or partially overhauled engines:**

a) With each partial overhaul (whether in Luftwaffe workshops or by the industry) every engine has to be marked with a yellow triangle (length of sides 15mm) as follows:
With in-line engines on the left side of the crankcase
With radial engines on the gearbox or front of housing.
Above this mark the engine serial number is to be applied (height of characters 40mm).
The number of triangles painted next to each other indicates the number of partial overhauls carried out.

b) After the first complete overhaul the yellow triangles are oversprayed and a red triangle (length of sides 15mm) is painted in their place. With every subsequent partial overhaul another yellow triangle is to be added. With every subsequent complete overhaul the yellow triangles are again deleted and replaced by a further red triangle. This results in showing
-the number of complete overhauls and
-the number of partial overhauls.

Visual levelling points
Marking of aircraft. Markings provided by the factory (e.g. red-painted rivet-heads) may under no circumstances be oversprayed by another paint and thus rendered unidentifiable. The aircraft painter requires these markings for the positioning of lettering.

Other markings
Surfaces which may be walked on have to be differentiated from those which may not be walked on by a 10mm wide broken line (length of dashes = 20 mm, spacing = 20 mm). Within these areas the following warning should be stencilled in bold, medium spaced letters: "Walk here only!" Delicate components such as trim tabs are to be marked: "Do not touch!"

Snap locks are generally marked by a red line in the direction of flight. The red line is positioned so that it protrudes 1cm to the right and left of the snap lock.

Special marking during the war
For the duration of the war all military aircraft display special markings in order to make identification of the flying units and their strengths more difficult for the enemy.
While in peacetime every airman is familiar with aircraft markings in their proper sequence, e.g. Luftkreis, Geschwader, Gruppe and Staffel numbers, in wartime these are disguised by being replaced with letters, i.e. they are secret.
Yellow wing tips, a yellow or white band around the fuselage are part of this. Decorations during the war include e.g. the number of aircraft shot down or ships sunk, which are painted on the vertical tail surface and which are familiar to everyone."

Markings of aircraft of light fighter units, 1938

On 14 December 1937 the following directive, Ref. No. FL.In 3 No. 730/37 II, was issued by the Generalstab of the Luftwaffe:

"**Markings of Aircraft of Light Fighter Units:**
The following markings come into force with immediate effect and render null and void all previous directives concerning the marking of light fighters.

Application of Markings:
National insignia (Balkenkreuz and swastika) as before.
The markings are applied only to the two fuselage sides. In order to ensure uniformity of appearance of the aircraft, the dimensions and locations as specified are to be strictly adhered to.

Organization and Structure of Aircraft within the Staffel
Markings of Staffel aircraft:
a) Staffel aircraft (including reserve machines) display the Arabic numerals 1 to 12, as follows:
1., 4., and 7. Staffel in white without border,
2., 5. and 8. Staffel in red with white border,
3., 6. and 9. Staffel in clay-yellow with black border.

(Author's note: White = RML 21, Red = RLM 23, Clay-yellow = RLM 04)

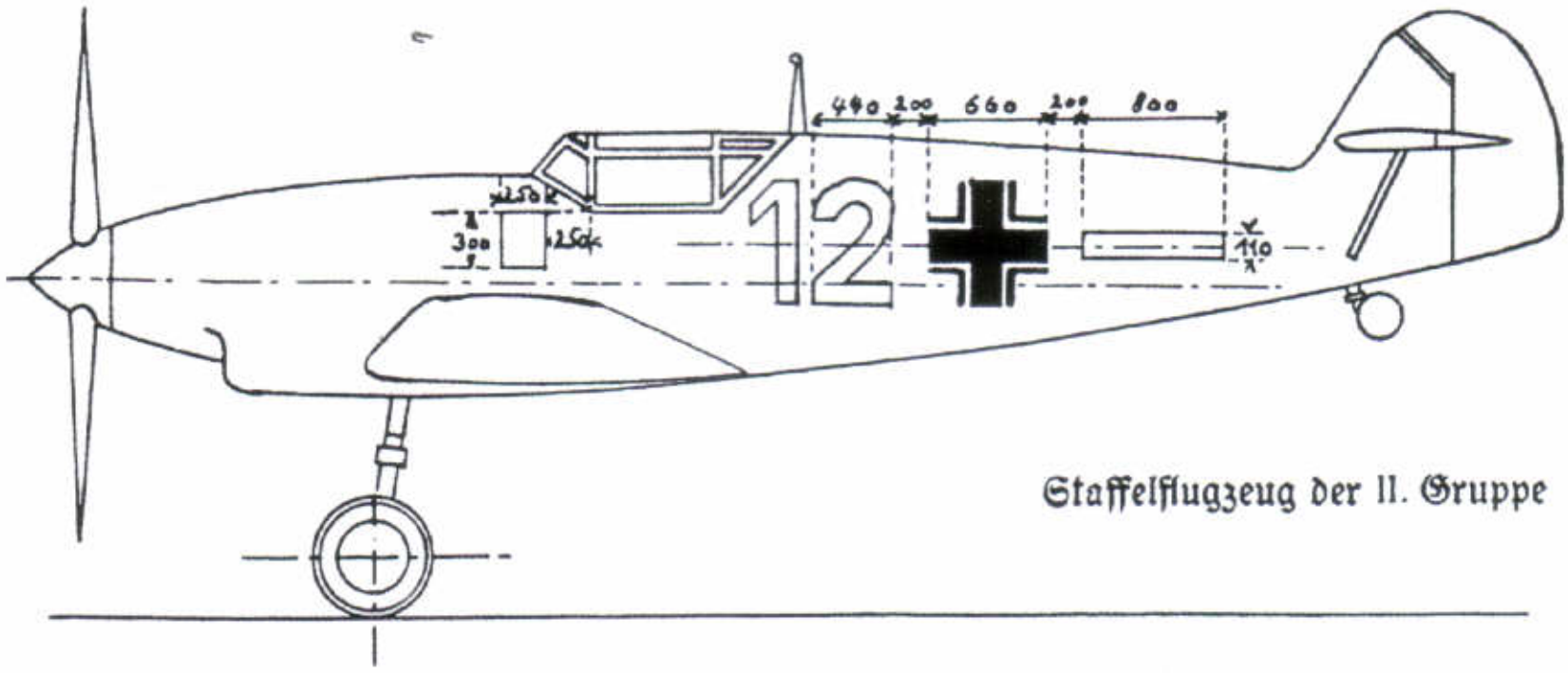
b) Markings of Gruppe and Gruppenstab
I. Gruppe of the Geschwader displays no Gruppe marking.
II. Gruppe displays a horizontal bar aft of the Balkenkreuz in the appropriate Staffel colour and border.
III. Gruppe displays a vertical bar also in the Staffel colour and border. Instead of a number, the aircraft of the Gruppenstab leader carries a chevron and triangle in black with white border. The Gruppe marking (I. no marking, II. horizontal bar, III vertical bar) is also in black with white border.
The two wingmen of the Gruppenstab are marked similarly to the leader's aircraft, but display only a chevron without the triangle.

c) Identification of the Geschwader and the three aircraft of the Geschwaderstab.
A 250 x 300 mm area (see sketch) is provided for the Geschwader badge. In this field a special Geschwader emblem is to be applied. The Geschwaderkommodore and Gruppenkommandeure are to forward suggestions by 1.2.1938. The emblems may only be affixed after permission is granted by R.d.L. (Reich Minister for Luftwaffe) and Ob.d.L. (C-in-C of the Luftwaffe). The 250 x 300 mm dimensions specified above have to be strictly observed.

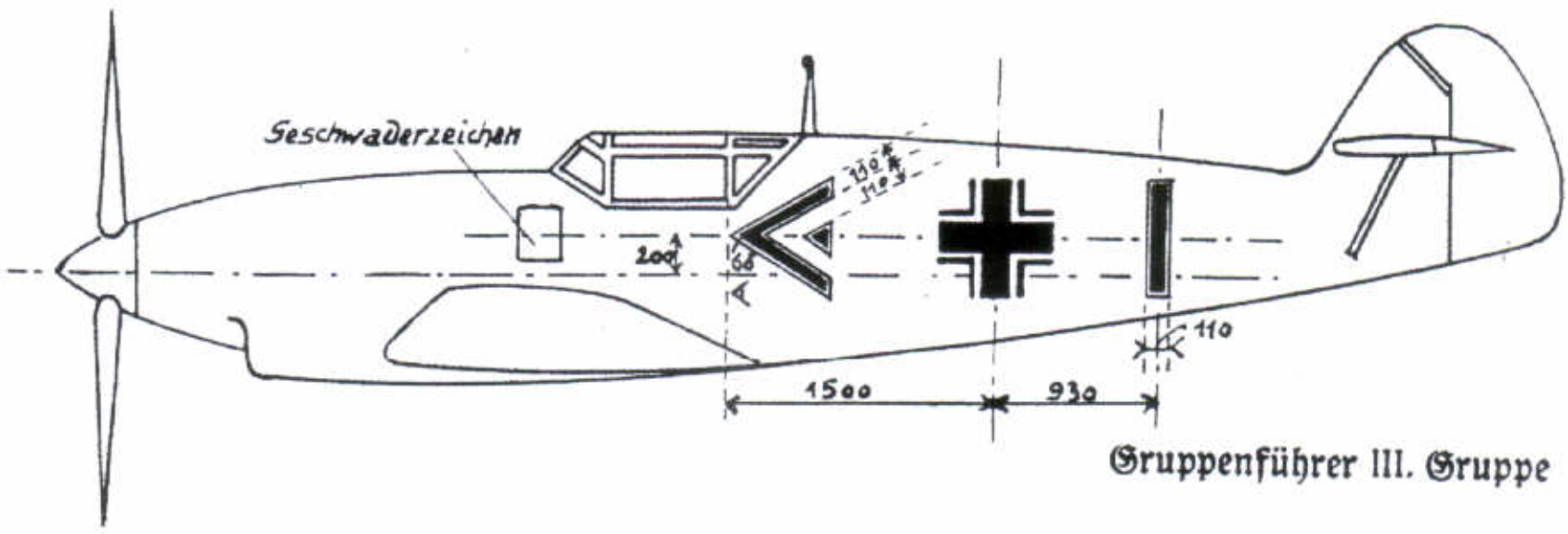
"The Geschwader leader's aircraft carries an arrowhead with horizontal bars extending back to the root of the tailfin. Colour black with white border.
The two wingmen display only the horizontal pointed bar without arrowhead. Colour black with white border.
The application of these unit markings relates only to Bf 109 aircraft models. It is unnecessary to change the markings on the He 51 and Arado 68, as these will be phased out with the delivery of the Bf 109.

A new directive for heavy fighters will be issued at the appropriate time."

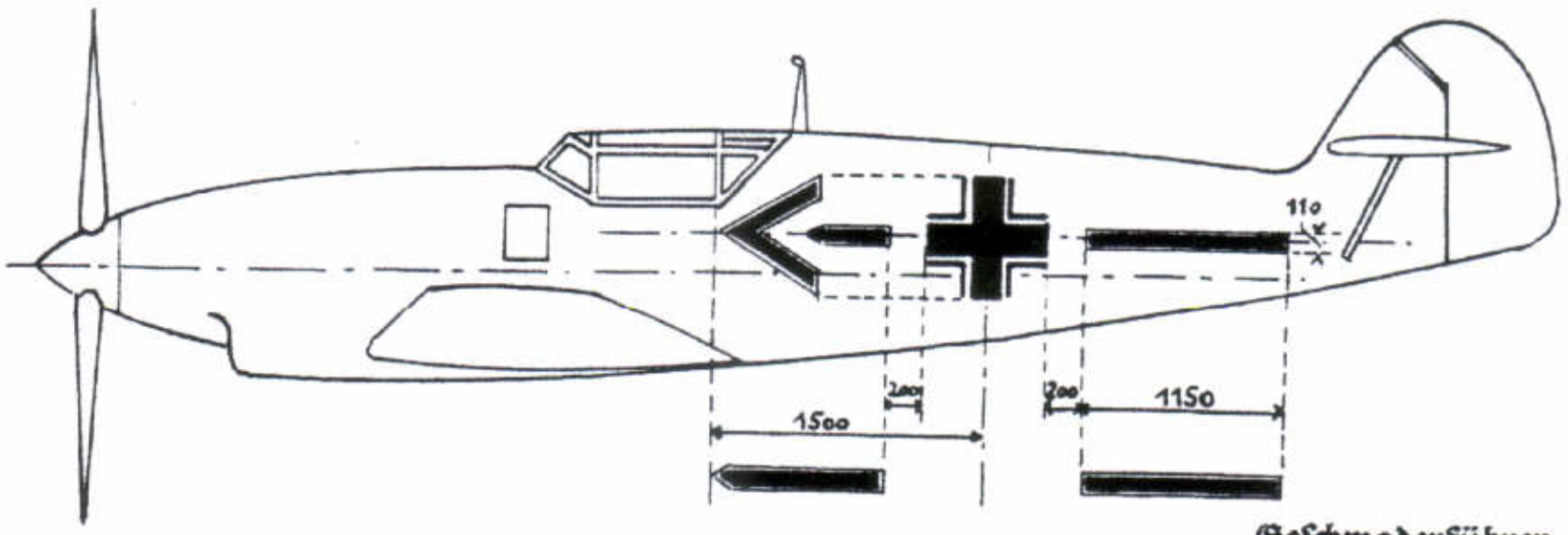
Bf 109 Markings



Staffelflugzeug der II. Gruppe



Gruppenführer III. Gruppe



Geschwaderführer

Kennzeichnung BF 109

Dimensions of Numbers:

Maße für Zahlen:

Höhe = 650 mm Breite = 440 mm Stärke = 110 mm

Height = 650 mm Width = 440 mm Thickness = 110 mm

Bei Zahlen und Zeichen mit Umrandung tritt ein Rand von 20 mm hinzu. Jedoch darf sich dadurch das Außenmaß nicht ändern. — Bei zweistelligen Zahlen ist der Abstand von Zahl zu Zahl 80 mm. Die Breite der 1 ist 260 mm.

For numbers and characters with outside borders a 20 mm border is added. However, this may not alter the overall dimensions.

With two-digit numbers the distance between numerals is 80 mm. The width of the 1 is 260 mm.

Ground-attack & fast bomber unit markings, 1943

"**I. Application of markings.**

National insignia (Balkenkreuz and swastika) as before.

II. Organization and structure of unit markings.

a) Markings of Staffel aircraft:

Staffel aircraft display Latin letters A to Z, as follows:

1., 5. and 9. Staffel in white

2., 6. and 10. Staffel in black

3., 7. and 11. Staffel in clay-yellow

4., 8. and 12 Staffel in blue

(Author's note: White = RLM 21, Black = RLM 22, Clay-yellow = RLM 04, Blue = RLM 24)

b) Markings of Gruppe and Gruppenstab:

I. Gruppe of the Geschwader has no Gruppe marking,

II. Gruppe displays a horizontal bar aft of the Balkenkreuz in the appropriate Staffel colour,

III. Gruppe displays a vertical bar also in the Staffel colour.

Instead of a letter, the aircraft of the Gruppenkommandeur displays a chevron and triangle in black with white border. The Gruppe marking (I. no marking, II. horizontal bar, III vertical bar) also in black with white border.

The other aircraft of the Gruppenstab are marked similarly to the Gruppenkommandeur's aircraft, but carry only a chevron without the triangle.

c) Markings of the Geschwaderkommodore and the aircraft of the Geschaderstab:

The aircraft of the Geschwaderkommodore carries an arrow head with a horizontal bar extending back to the root of the tailfin. Colour black with white border. The other aircraft of the Geschwaderstab display only a pointed bar without the arrowhead. Colour black with white border.

d) Geschwader emblems and ground-attack triangles used hitherto are deleted.

Dimensions and method of application of the markings for Bf 109 and Fw 190 aircraft. The new markings being applied to the Fw 190, starting with the Balkenkreuz, use the same spacing and the same size as the Bf 109."

Changes to aircraft markings, 1943

"The regulation governing aircraft in Special Luftwaffe Directive 1930, p. 9 No. 7, section II (*see page 158*) is to be amended as follows:

Organization and structure of unit markings

a) Staffel aircraft (including reserve machines) display the Arabic numerals 1 to 16 as follows:

each 1. Staffel in a Gruppe in white

each 2. Staffel in a Gruppe in black

each 3. Staffel in a Gruppe in clay-yellow

each 4. Staffel in a Gruppe in blue with white border.

(Author's note: White = RML 21, Black = RLM 22, Clay-yellow = RLM 04, Blue = RLM 24)

b) Markings of Gruppe and Gruppenstab:

I. Gruppe: no Gruppe marking,

II. Gruppe: horizontal bar aft of the Balkenkreuz in the appropriate Staffel colour,

III. Gruppe: vertical bar also in the Staffel colour.

IV. Gruppe: a wavy bar in Staffel colour and border.

Instead of a number, the aircraft of the Gruppenstab leader carries a chevron and triangle in black with white border as well as the Gruppe marking (I. no marking, II. horizontal bar, III. vertical bar, IV. wavy bar) also in balck with white border. The other aircraft of the Gruppenstab are marked similarly to the Gruppenkommandeur's aircraft, but display only a chevron without the triangle.

c) Identification of the Geschwaderkommodore.

The aircraft of the Geschwaderkommodore carries an arrow head with a horizontal bar extending back to the root of the tailfin. Colour black with white border. The other aircraft of the Geschwaderstab display only a pointed bar without the arrowhead. Colour black with white border."

309

Bf 109 Markings

Ground Attack Units

Marking and licensing of gliders 1943

"Under Ref. No. 38 p 38 No. 1800/43 (GQM 2 Dept./ II a)/ LB 2 II) the Reich Minister for Aviation and C-in-C of the Luftwaffe has issued the following directive:

1. Gliders (collective term) display a 4-letter marking (registration marking). Inserted between each of the two pairs of two letters is, in the case of Luftwaffe gliders a Balkenkreuz, and with civil aviation gliders a hyphen, e.g:
Luftwaffe XY + AB
Civil TZ – XR
The further marking of civil aviation gliders with the German national insignia D is to be omitted for the duration of the war when operating within the Reich or in occupied territories.

2. Luftwaffe gliders and civil aviation gliders (the latter for the duration of the war when operating within the Reich or in occupied territories) which, according to the design regulations for gliders (BVS), belong to weight class (Bgr.) 2 and ff, uniformly carry a black swastika on the rudder as the national insignia.

3. The new markings (registration markings) are issued – as with powered aircraft – by the Reich Minister for Aviation and C-in-C of the Luftwaffe, Test Centre for Aircraft / LB 2, Berlin-Adlershof; this centre also administers the master register for gliders.
"4. The Reich Minister for Aviation and C-in-C of the Luftwaffe Test Centre for Aircraft / LB 2 issues the instructions required for marking amendments and the licensing process.
No amendments of the directive on air traffic will be made until further notice.

5. The order comes into force as of 1.7.1943.
Any contrary regulations are herewith null and void."

Markings of air ambulances, 1941

The *Flugzeugmaler* 1944 (The Aircraft Painter) contains the following regarding the marking of air ambulances:

"According to L.Dv 521/1, (see Chapter 11) ambulance aircraft will be marked as follows:

1. The aircraft retain the standard camouflage allocated to the type.

2. The national marking (swastika) is placed on the rudder unit as for front line aircraft.

3. Instead of the Balkenkreuz on the wings and fuselage, the red cross will be applied on a white circle. The ratio of circle diameter (D) to the length of the bar (a) of the red cross to the width of the bar (b) is D:a:b: = 7:6:2.

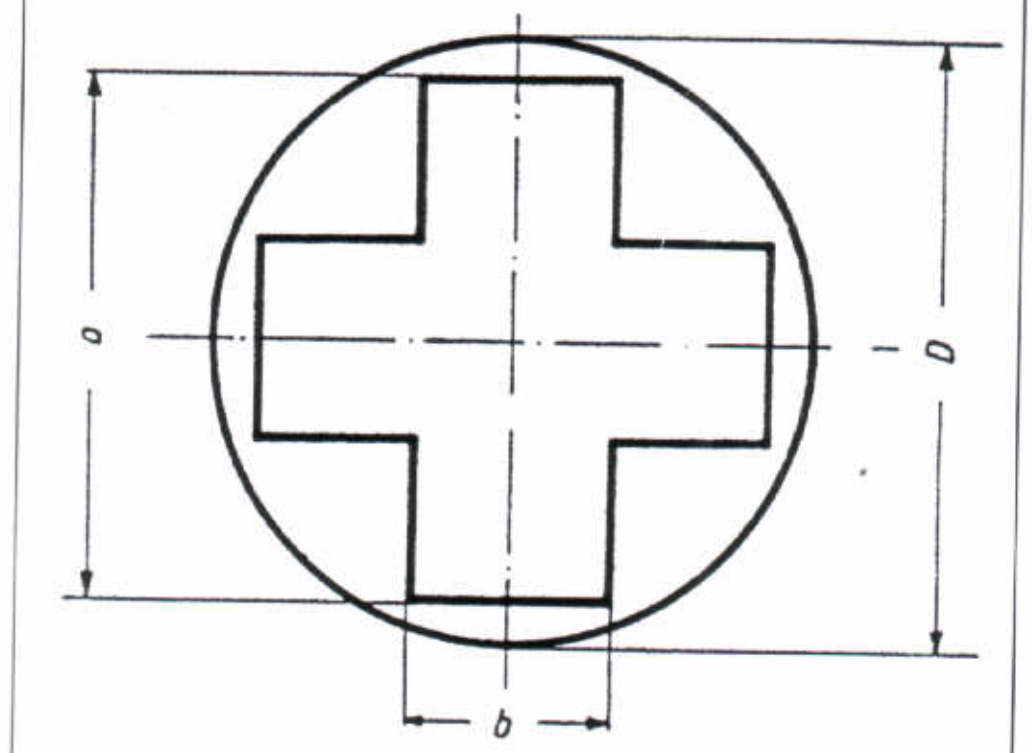


Fig. 56 Ambulance aircraft marking

The following dimensions will be used:

D =	52	70	87	105	122	140	157	175	192	210
a =	45	60	75	90	105	120	135	150	165	180
b =	15	20	25	30	35	40	45	50	55	60

All dimensions are indicated in centimetres.

The diameter of the white circle will be so selected using the above measurements that it covers the Balkenkreuz (on front line aircraft). The red cross will then be inserted.
Aviation lacquers used for
Spraying 7160.21 and 7160.23
Painting 7164.21 and 7164.23."

Ferry markings

Ferry Markings 1937

The following directive was issued by the Reich Minister and C-in-C of the Luftwaffe on 28 September 1937 and is quoted here in its entirety:

"Difficulties have arisen from the D-markings not being reported as free for further use after transfer flights, and from D-licensing documents not being amended after an aircraft has been given military markings. In addition, problems have arisen with the markings of aircraft which have had to be delivered to the manufacturer's test centre or abroad and which, as a practical measure, have received only a temporary license and not the full German markings.
The following provision is therefore to be made:
From 1.10.1937 aircraft without registration markings which are to be transferred from a manufacturer or repair-shop to a Luftwaffe station are to be given temporary German military markings for the duration of the transfer flight. Upon arrival at the aircraft's destination, these are to be removed again and replaced by the unit marking (Balkenkreuz and number).

"As well as the registration marking, the national flag insignia is to be applied on the vertical tail surfaces in accordance with the regulations issued for military aircraft.

I. Form and application of ferry markings
The ferry marking consists of four letters which are applied, as per the sketch below, to the underside of the wing, with biplanes on the underside of the lower wing. Size and spacing as per those of corresponding aircraft with civil markings (see Air Traffic Regulation of 21.8.1936, Reich Law Gazette).

In addition, the aircraft are to receive a Balkenkreuz in the prescribed size, form and colour in the locations specified for this purpose (on both fuselage sides, as well as on the upper surface and underside of the wing, with biplanes on upper surface of the top wing and underside of the lower wing). The national flag insignia must be displayed on both sides of the vertical tail surfaces. The colour of the transfer marking is black and must be removable with water; the colour of the Balkenkreuz is black, non-removable.

II. Period of validity
Ferry markings are valid only for the duration of the transfer flight. Upon arrival of the aircraft at its destination they are to be washed off immediately. Within three days of delivery the unit taking possession of the aircraft is to inform the production management of the supplying factory that the transfer markings are free for further use.

III. Air traffic regulations
Aircraft with the described transfer markings are governed by the same air traffic regulations as apply to aircraft with military markings.

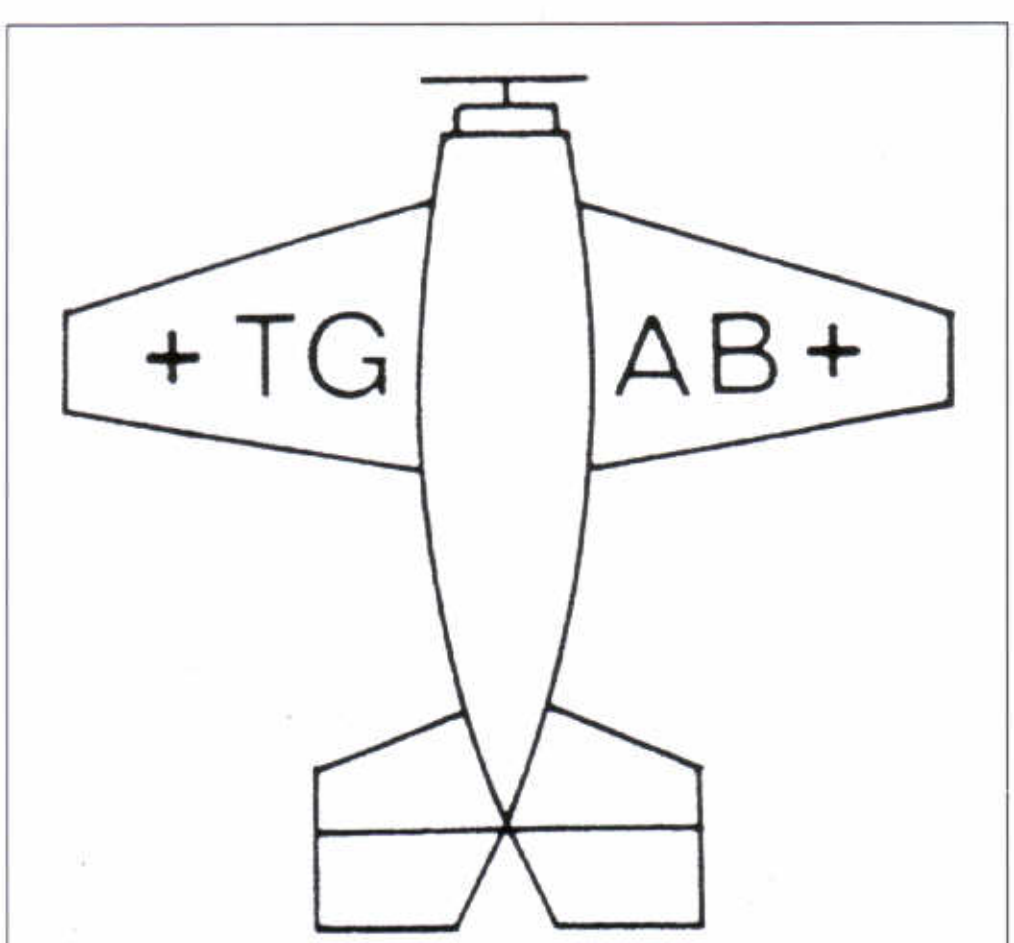
IV. Radio communication
For aircraft with ferry markings radio communication is governed by the same regulations as apply to aircraft with military markings. The call sign comprises the ferry marking prefixed by the letter D (example: transfer marking – PABA -, call sign DPABA). The call sign thus created differs from those of aircraft not operating under temporary license, and of aircraft with civil markings, in that the first letter after the "D" is not a vowel (A,E,I,O,U), but always a consonant."

Ferry Markings 1939

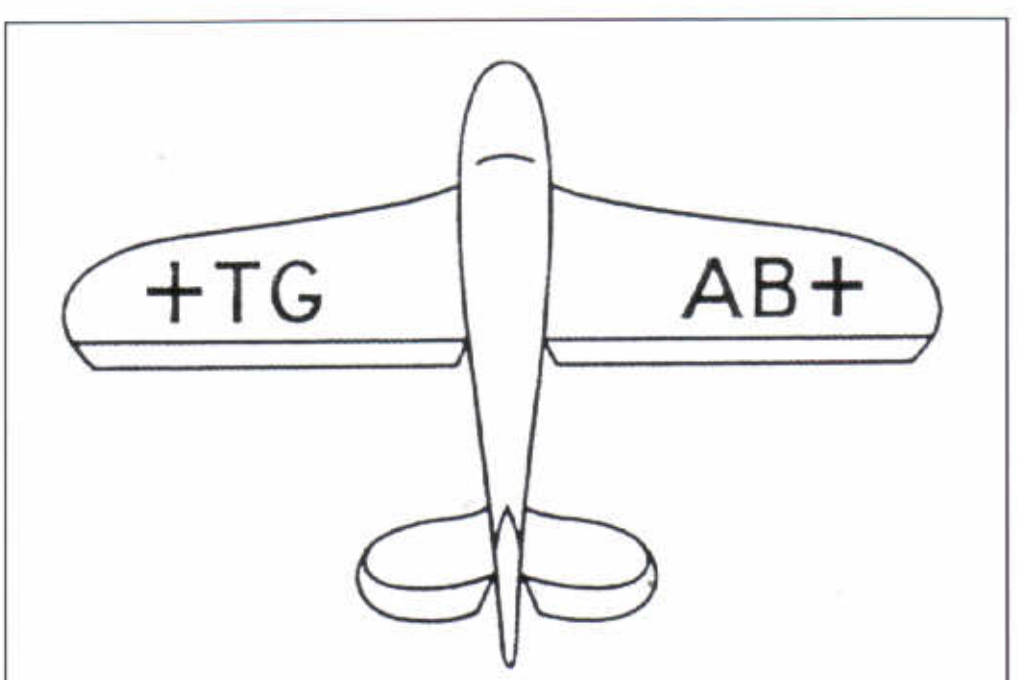
Ferry markings on Luftwaffe aircraft were introduced by Luftwaffe Regulation Notice No. 9 of 20 February 1939:

"Transit markings for military aircraft.
The following order is made, withdrawing the orders concerning transit markings for military aircraft L.C. II No. 1045/37 II8 of 23.9.1937 and ref. 38p48 L.B. II, 4 No. 4909/37 of 25.9.1937, and the order issued to certain departments only of the RLM, Ref. 38e45 L.C. 3 No. 195/39 (3V) of 16.1.1939.

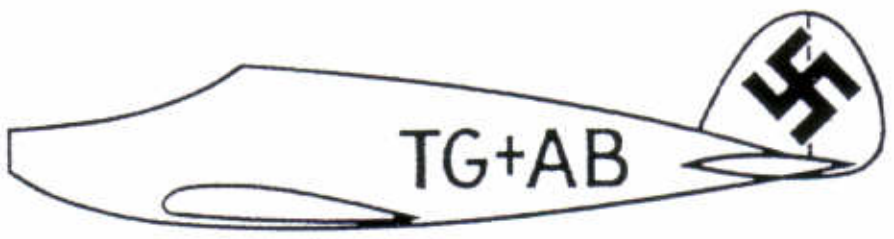
I. General
Aircraft that do not yet possess a final military marking will receive a special transitional marking for the transit flight from the manufacturer's works, repairers, aviation office or air park to a Luftwaffe unit which will be removed on arrival at destination and replaced by the military marking (Balkenkreuz and number or WL and four letters). The Balkenkreuz will be applied in the prescribed size, shape and colour next to the transit marking on the underside of the wing (for multi-planes, only underneath the bottom wing). The swastika will also be applied to the rudder unit in accordance with the regulations issued for the Luftwaffe.



Ferry Markings 1937



Ferry Markings 1939



"II. Shape and application of transit markings
The transit marking consists of four letters placed on the underside of the wing according to the following sketch (for multi-planes, only on the underside of the bottom wing) and on the two sides of the fuselage. Item 4 in Annex 1 to the Aviation Regulations of 21.8.1936 (Reich Law Gazette 1936, Part 1 pp. 675 and 691 or R. f. L. 1936, pp. 638 and 657) applies as to size, spacing and colour of the letters. The colour of the transit markings must be washable; the Balkenkreuz will be applied with non-washable colour to aircraft with built-in weaponry and with washable colour to all other aircraft.

III. Validity
The transit marking applies only for the length of the transit flight. When the aircraft arrives at destination it must be washed off without delay. The unit accepting the aircraft will advise the works inspector at the delivery plant or the aircraft office or airpark within three days following collection that the transit marking has been removed to make way for the new one.

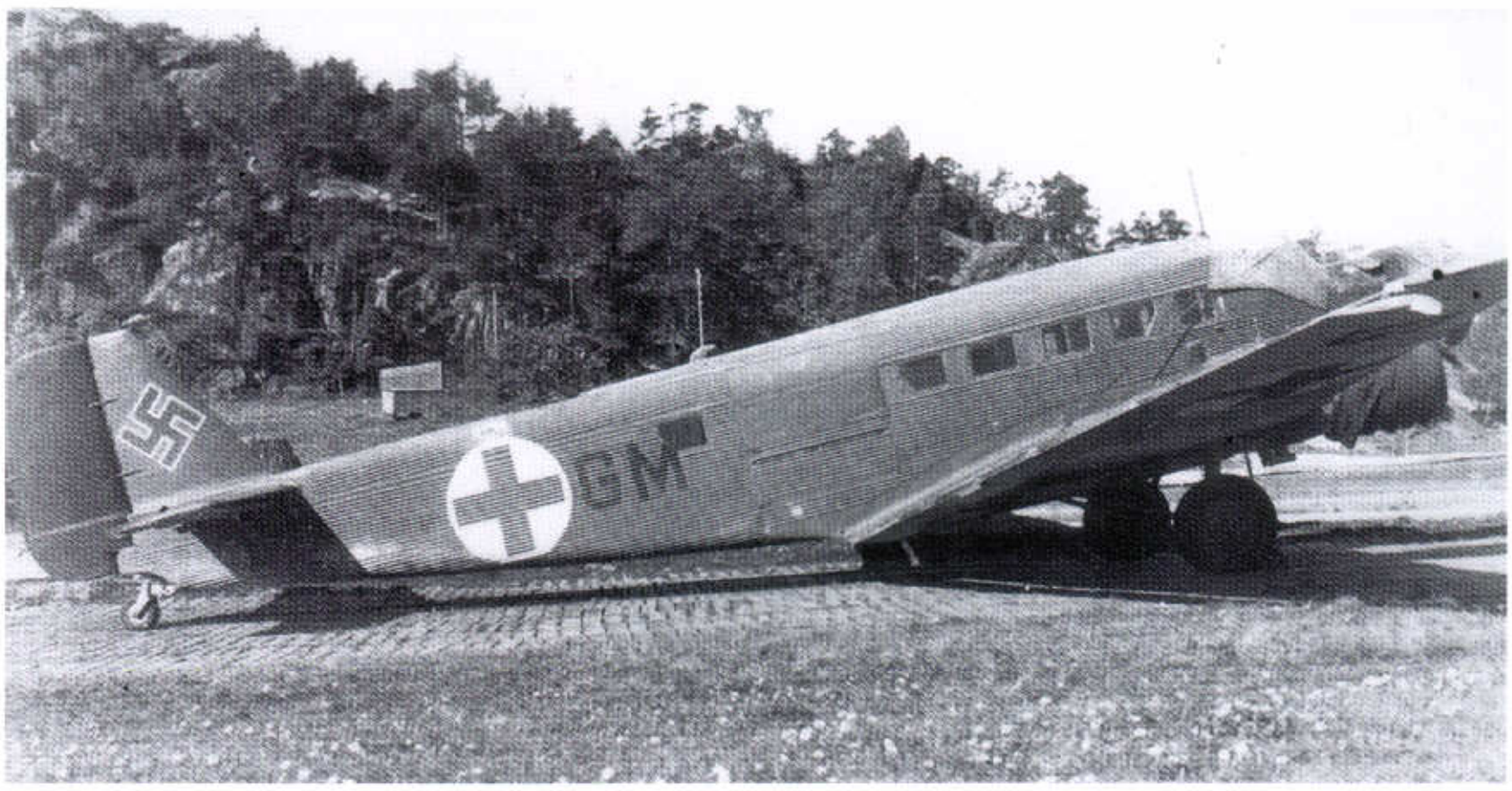
IV. Traffic regulations
The same traffic regulations as for aircraft with military markings apply to aircraft with the transit markings described when in transit to Luftwaffe units.

V. Radio traffic
The same provisions as for aircraft with military markings apply to radio traffic from aircraft with transit markings. The transit marking will be used as a call sign preceded by the letter D (e.g. transit marking "+TGAB+", call sign "DTGAB"). The call sign formed in this way differs from that on aircraft with civil markings in that the first letter after the "D" is not a vowel (A,E,I,O,U,Y) but always a consonant."

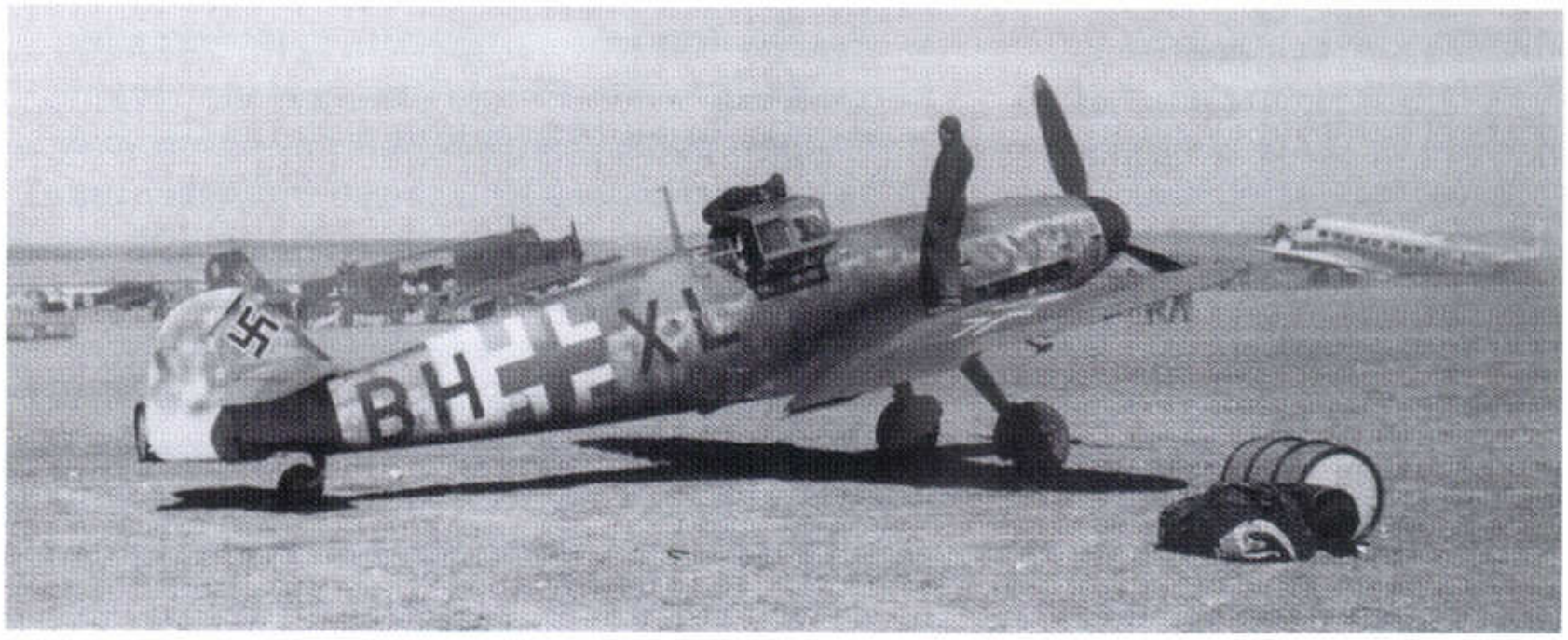
"VI. Issue of transit markings
Transit markings are assigned by RLM – L.B. II 8 to the factory inspectors, aircraft offices and airparks. These units will keep records of the issue of markings so that it will be evident at all times which aircraft was issued a particular marking on a particular day and who undertook the transit. Manufacturers may still apply for civil markings (countersigned by the works inspectorate) only if it is clear that the aircraft will actually retain this marking and will not subsequently have a military marking applied. Transit markings hitherto assigned by the building inspectorates will be retained. The transit markings for aircraft offices and airparks will be allocated by special order."

310 Below left: *Diagrams showing transit markings in 1937 and 1939*

311 Right: *A Ju 52 marked as a medical aircraft. The markings were painted in accordance with the regulations detailed on page 169. Again this aircraft appears to have had a single overall finish of 71 and 65. The swastika is from the 'mid-period' without a black border.*



312: *A brand new Fw 58G-1, TR+AU, in splinter 70/71 camouflage, fully marked as an ambulance aircraft in accordance with the regulations. Note how bright the undersides appear*



313: *This clean Bf 109G-2 displays to advantage its Stammkennzeichen, BH+XL, which served as a ferry code for delivery to its intended unit (JG 3 or JG 52). The white theatre fuselage band indicates that it is on the southern sector of the Russian Front in 1942. The aircraft is finished in the standard 74/75/76 camouflage. Note that the swastika is in the mid-war style without a black outline, while the Balkenkreuze are the simplified white outline type, that on the fuselage having had the centre filled in with 75 in accordance with the order detailed on page 155*

314: *The code on this Fw 190A-7/R6 is unusual as it is similar to transit codes used in the pre-war days by some aircraft manufacturers e.g. Dornier: DU+, Junkers: JU+ and Heinkel: BU+. Here it is probably entirely coinicidental but may represent a satellite Focke-Wulf factory or licensed producer or possibly a Luftwaffe experimental establishment. Letters are black, while the insignia are the mid to late war style, the fuselage cross being infilled with 75*

315: *An early production Bf 109G-14 with a small tail, probably from a training unit on account of the high fuselage number, (Blue 62?) wears the extra large Werk Nummer, 781993, intended as a transit code. It also has a narrow yellow tail band which might indicate its trainer status or use on the Eastern Front*

316: *This Fw 190D-9, WNr 500647, is the same 'Brown 4' of 7./JG 26 shown in photo 306. Abandoned at Hustedt it wears the black and white Reich Air Defence bands allocated to the unit (see opposite) and a horizontal III Gruppe bar. It appears that the aircraft weras only a light camouflage of a variant of 76 and a dark green (?) on the upper surfaces, the underside remaining unpainted in accordance with the late-war directives on material saving. (See page 183)*

The transit markings described above remained the standard during the war until *Sammelmitteilung* 1 of July 1944 made the following change:

"**Abandonment of transit markings**
The markings used hitherto consisting of black or white markings in washable colour on the fuselage will cease to apply with immediate effect. Instead, the works number without a suffix, i.e. the number on its own, will be applied to the rudder unit, in shade 22 or 21, aviation lacquer 7160 or 7164 ~~or~~ 7165. The height of the figures is 25 cm, possibly smaller e.g. if the Balkenkreuz would be encroached upon."

The above order from the *Sammelmitteilung* is therefore the reason for the emergence of the large serial numbers on the rudder unit of aircraft produced in the last months of the war.

Propeller spinner spiral markings

Allied intelligence used 'Ultra' to decrypt a Luftwaffe signal dated 10 February 1944 which stated:

"Additional orders of 10th for units operating in defence of the Reich:
a. Band around fuselage to remain as marking for individual Geschwader
b. In principle, all Kommodores and Kommandeurs to fly with white fins and rudder.
c. All fighter aircraft of Luftflotte 3 and Luftflotte Reich to have black and white spiral painted on spinner. One and a half spirals turning same direction as spinner, width one fifth of diameter of spinner."

An order from Stab to II./JG 11 on 25 June 1944:

"With immediate effect, aircraft to be marked only with spiral on propeller spinner, cross, tactical number and Gruppe mark (bars)."

On 29 June 1944:

"Now known that aircraft marking instructions apply to all Luftflotte 3 aircraft. Spiral on spinner to be black and white. Additional markings to be retained exclusively for fighters, ground attack and reconnaissance aircraft."

7 Jagd Division noted on 14 July 1944, referring to Luftflotte Reich orders of 5 July:

"All fighter aircraft going to the West on operations to be provided only with black and white spirals on spinner. All other special identification markings to be discontinued."

Recognition bands for Reich Air Defence

For Reich Air Defence, recognition bands were introduced in the final stages of the war, formalised in an order dated 20 February 1945:

"**Subject: Jagdgeschwader markings**
By order of the Reichsmarschall and for the purpose of improving aerial recognition, Jagdgeschwader aircraft are to be marked by fuselage-encircling coloured stripes as shown in the appended enclosure. The attention of troops down to platoon level is to be drawn to these markings which should simplify the recognition and distinction of our own aircraft.
IA
(signature illegible)
Leutnant u. Ord.-Offz."

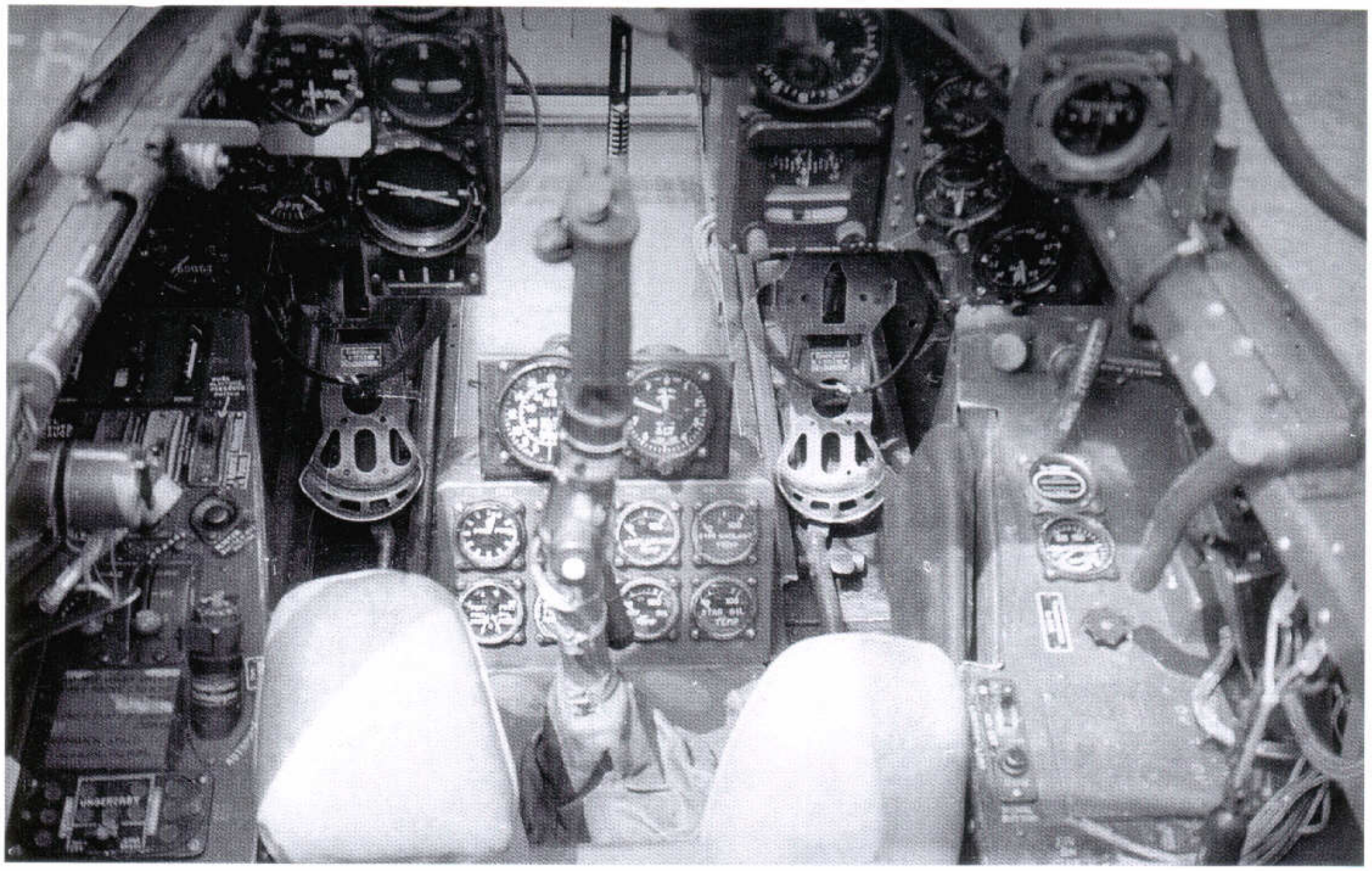
The attachment sheet contained diagrams of the colours as they were intended to be applied on the aircraft. For one colour a width of 900mm was specified; for two 450mm each and for three 300mm each. By these means Luftwaffe fighter units could be more easily recognised in the air. The following colour combinations, shown in the sequence they appeared in the original orders, are known for the individual squadrons. In each case the colour towards the front of the aircraft is noted first:

JG 1	Bright Red
JG 3	White
JG 11	Yellow
JG 27	Bright Green
JG 53	Black
JG 54	Bright Blue
JG 5	Black/Yellow
JG 7	Blue/Red
JG 26	Black/White
JG 52	Red/White
JG 77	White/Green
JG 301	Yellow/Red
JG 2	Yellow/White/Yellow
JG 4	Black/White/Black
JG 6	Bright Red/White/Bright Red
JG 51	Bright Green/White/Bright Green
JG 300	Bright Blue/White/Bright Blue

The latest research has revealed that other forms of Reich defence bands also existed. These were chequered and followed logically from the fact that there were more squadrons than variants listed in the above table. This method of banding was allocated to industrial protection units. Another possibility which the author believes to be correct is that the chequered bands were allocated to new fighter squadrons. In both cases no definitive explanation is possible without appropriate documents. Tentative identifications of the chequered bands are:

III./KG(J) 54	Green/white (J=Jagd=Fighter)
KG(J) 6	Red/black
KG(J) 54	Blue/white
3./ISS 1	Blue/green (ISS= Industry Protection Flight)

In the end, fighter squadrons were made up from practically anything that could fly, which also explains why the number and style of fuselage bands as previously used no longer proved adequate.



AIRCRAFT INTERIORS

Silver, grey, black...

The painting of aircraft interiors was also regulated by RLM rules. This practice served in first instance as preservation and protection against corrosion. In the course of time, however, marked variations occurred especially in interior painting schemes which will also be explained here.

The directive for the development of suitable aircraft paint at the end of 1936 (see page 198) constituted the first stipulations laid down by the RLM:

"Internal components of aircraft:
Shade of top coat: Grey 02"

Notwithstanding the variety of design, the same applied in principle to all types. L.Dv 521/1 of 1938 states the following:

"a) Fuselage, wings, rudder unit, control unit and propelling system excluding the engine: aviation lacquer group 04 on all metals.

For aircraft with silver shade, aviation lacquer group 03 on all external metal.

Shade 66, i.e. aviation lacquer 7107.66, will be used for instrument panels."

This therefore means that the internal colour was executed either in shade 01 or 02. The cockpit was also painted in 02 and only the instrument panel in shade 66, to prevent dazzle.

L.Dv 521/1 of 1941 further states:

"Interior.
The interior colour is in shade 02 in principle. Shade 01 may not be used here. Only the interior walls of glazed cockpits and canopies will be protected against dazzle with shade 66 (corresponds to RAL shade 7021)."

The difference from the 1938 edition is evident – simplification by ceasing to use shade 01 and interior painting of the cockpit and canopy in shade 66.

The greatest change in interior colours was introduced on the publication of HM Notice No. 7/42 *Simplifying Surface Treatment for Land-based Aircraft* of 18 May 1942 explains:

317 Above: *A pilot's view of the Me 410A-3 showing the nose glazing which allowed a good view for landing and the generally Schwarzgrau 66 finish applied to the structure. Most other components are black or natural metal. Instrument bevels and knobs are in various bright colours; the seat cushion could be yellow or grey*

"Aviation plants have agreed in consultation with the RLM that, in order to save on raw materials, energy, labour and working time and to make way for other important work, surface protection for land-based aircraft will be simplified even further than before. The measures listed below substitute and cancel HM Notice No. 056 concerning the simplification of surface protection for land-based aircraft. The following applies with immediate effect to the simplified surface protection, types Fw 190, He 177 and Ar 96.

1. Parts with Flw 3305 (Hy 5), Flw 3310 (Hy 7), Flw 3315 (Hy 9) and Flw 3116 (Duralplat) not exposed to the free airflow will not receive any kind of surface protection. Care will therefore be taken at individual workshops that ready finished parts where the above aviation materials have been used will be put forward for inspection carefully freed of shavings and also of flux at the welds, so that aircraft can then be supplied direct to the units. The management of the various plants will issue grey index cards accordingly. The entry "paintwork" will in future be left blank for parts with the above aviation materials. The materials identification will not be removed.

2. Fuel tanks of
Flw 3000 (aluminium), Flw 3116 (Duralplat), Flw 3355 (Pantal or Legal) will be left uncoated both inside and out. However, protective care will be taken that all flux residues and metallic impurities such as shavings, etc. are removed from the tanks.

3. Radiators of
Flw 3000 and Flw 3355 will remain unprotected both inside and out. However, care will be taken that flux residues and metallic impurities are removed without trace.

4. Flw 3126 in States 4 and 5 remains unprotected but will be protected as in the past in State 9.

5. Galvanised steel parts will be left uncoated while all other steel parts will be treated as before.

6. Flw 3115 will be coated as in the past.

7. Electron will receive two coatings as in the past.

8. Cockpits will receive only one coating of shade 66 instead of the two in the past.

9. The camouflage will be executed as in the past by applying a layer of lacquer.

The proposed measures would achieve widespread simplification since the parts referred to in item 1 are assembled without any protection. The only attention paid during assembly is that steel and electron parts are adequately insulated, in accordance with items 5 and 7. Steel rivets must subsequently be protected by painting, while light metal rivets can be left unprotected.

So that industry can make best possible use of the permitted simplification of surface protection for land-based aircraft, it is proposed that camouflage be applied only after the individual sub-assemblies have been completed.

We know that on lengthy storage unprotected components made from materials 3000, 3116, 3125, 3305, 3315 and 3355 may corrode. The unprotected parts of aircraft may also be prone to surface encroachment after a period in operation. Apart from this normal stress through the weather, unprotected parts are subject to further corrosive attack following penetration of the fuselage with grass and earth. However, this is acceptable since it has been proved that the surface alterations ensuing produces no appreciable loss of airworthiness over a few years. Components subject to minor surface alteration can therefore be left as they are and need not be touched up since touching up work eliminates the savings made. The surface protection hitherto applied to types Ar 240 and Ar 232 is retained. Similarly, surface protection for naval aircraft will not be simplified since the effects of corrosion cannot be overlooked."

The statements in the above text are clear; interior painting of aircraft was already abandoned in 1942. This means that materials, landing gear compartments, access flaps to the fuselage and so on, as for example on the Fw 190, were no longer painted and the bare metal was left in its aluminium colour.

Nonetheless, there was still further potential for economising. This is evident from the following circular to all production, conversion and repair establishments and their inspectorates from the RLM Technical Office, Ref. 70 R 10.11 GL/C-E 10 No. 4135/44 (IVE) of 10.3.1944 concerning the interior painting of metal land aircraft.

"Under the present Regulations, internal metal parts of land planes of steel and electron must be painted
Once with aviation lacquer 7101.99 and
Once with aviation lacquer 7109.02 (or 66) or
Once with aviation lacquer 7101.99 and
Once with aviation lacquer 7121.02 (or 66) formerly 7122, or
Twice with aviation lacquer 7121 (formerly 7122).
In cases where single paint is prescribed, aviation lacquer 7121.02 or 66 (formerly 7122) will be used.

We have now succeeded in securing raw materials for aviation lacquer 7101.99 originally used as primer in "such a way that this lacquer is uniformly prescribed as interior coating instead of aviation lacquer 7121

(formerly 7122). It will therefore be supplied in shades 02 and 66 in addition to shade 99.
This measure will at the same time extensively relieve the raw material base for aviation lacquer 7121 (smooth finish) and so help to secure the standard finish for metal aircraft. It will be all the more effective since it has been found that well over half the paints supplied in aviation lacquer 7121 (or 7122) quality is still used for interior painting despite the simplification measures.
Since interiors need not be finished smooth, use of aviation lacquer 7101 instead of 7121 will also mean substantial savings in time for the grinding process in the paint industry, quite apart from the fact that aviation lacquer 7101 is especially suited for painting steel and electron parts.
For these reasons, the paints industry has with immediate effect been prohibited from producing aviation lacquer 7121 (or 7122) in shades 02 and 66. However, unfinished orders in hand will automatically be delivered in aviation lacquer 7101.02 or 66
The aircraft industry is hereby prohibited from using aviation lacquers 7121.02 and 66 or 7122.02 and 66, naturally after existing stocks have been used up.
Exception: only in the few cases where shade 02 is to be used for standard finishes may aviation lacquer 7121.02 be requested from the paints industry with express reference to its use as an exterior finish.
Aviation lacquer 7101 in shades 02 and 66 will be treated like aviation lacquer 7121, ready for use.
Liquid lacquers 7101 and 7121 (or 7122) may not be mixed.
No alteration is necessary to the OS lists unless necessary for internal organisation purposes. However, the following must be taken into account when the OS lists are redrafted. For technical reasons, shade 02 cannot always be kept in stock. As this is unimportant for interior painting, failure to comply fully with the shade specimen is no reason for complaint.
The interior coatings of metal-built land planes will therefore be composed as follows in future:

A) Two coat process (for steel and electron)
1. Aviation lacquer 7101.99 once only
   Aviation lacquer 7109.02 or 66 once only or
2. Aviation lacquer 7101.99 one coat
   Aviation lacquer 7101.02 or 66, one coat, or
3. Aviation lacquer 7101.02 or 66, two coats.

In case 3, suitable control measures are needed to ensure that two coats are applied as before.

B) Single paints (as prescribed for simplified surface protection)
Aviation lacquer 7101.02 or 66 one coat.

NB: Reference is made again to the need to save paint and thinners and to the implementing orders already issued for this purpose (paints savings officers, etc.)"

The circular quoted above contains a number of very interesting passages.

" ... It will be all the more effective since it has been found that well over half the paints supplied in aviation lacquer 7121 (or 7122) quality is still used for interior painting despite the simplification measures.

" ... Exception: only in the few cases where shade 02 is to be used for standard finishes may aviation lacquer 7121.02 be requested from the paints industry with express reference to its use as an exterior finish.

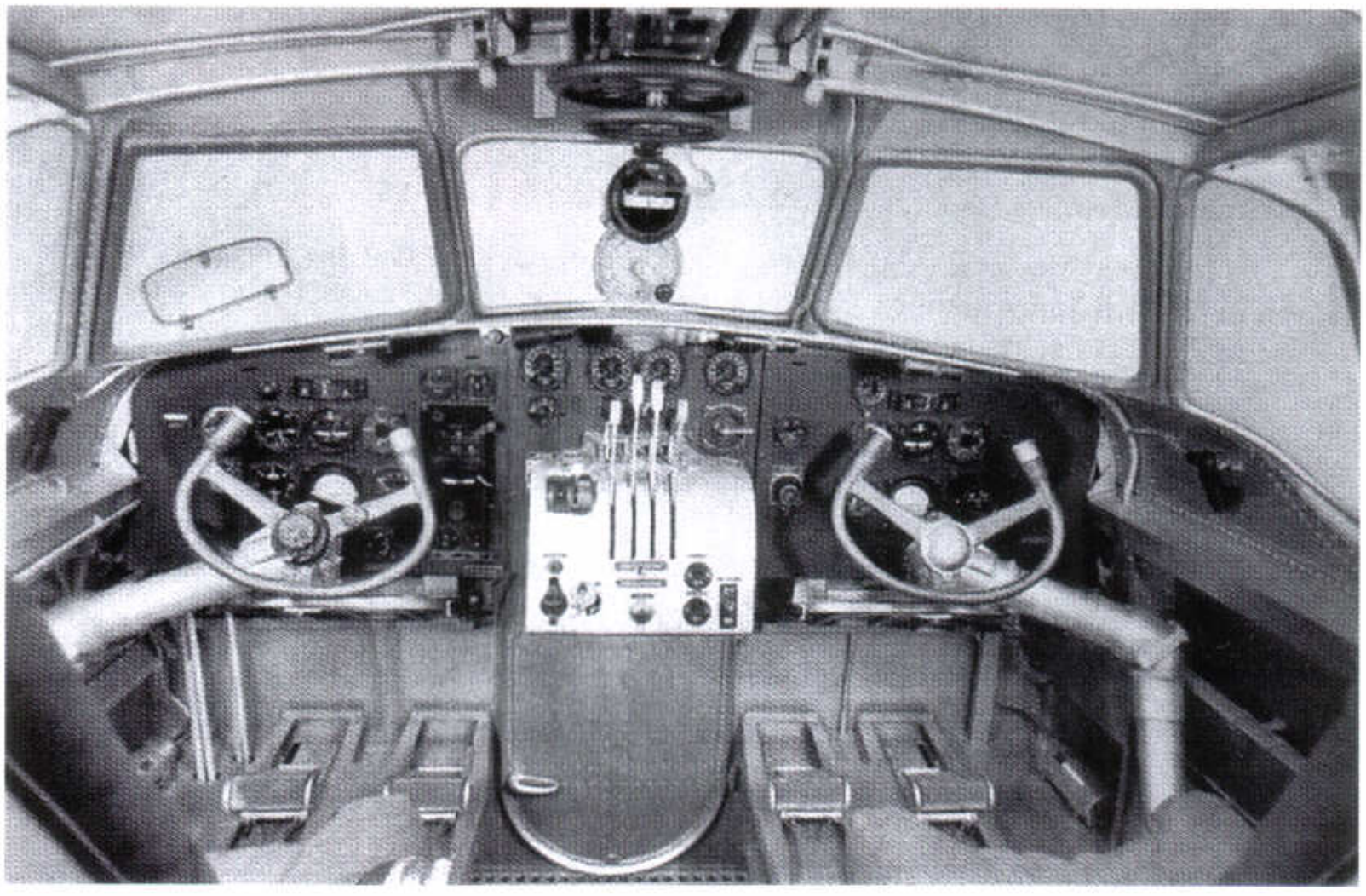
" ... For technical reasons, shade 02 cannot always be kept in stock. As this is unimportant for interior painting, failure to comply fully with the shade specimen is no reason for complaint."

An official letter from the RLM repeatedly pointed out that a shade cannot always be guaranteed. The reason is obvious: the shortage of raw materials. Just think of the effects on production of all other paints and their shades. Uniform shades no longer existed. They varied more or less strongly depending on batch and manufacturer.

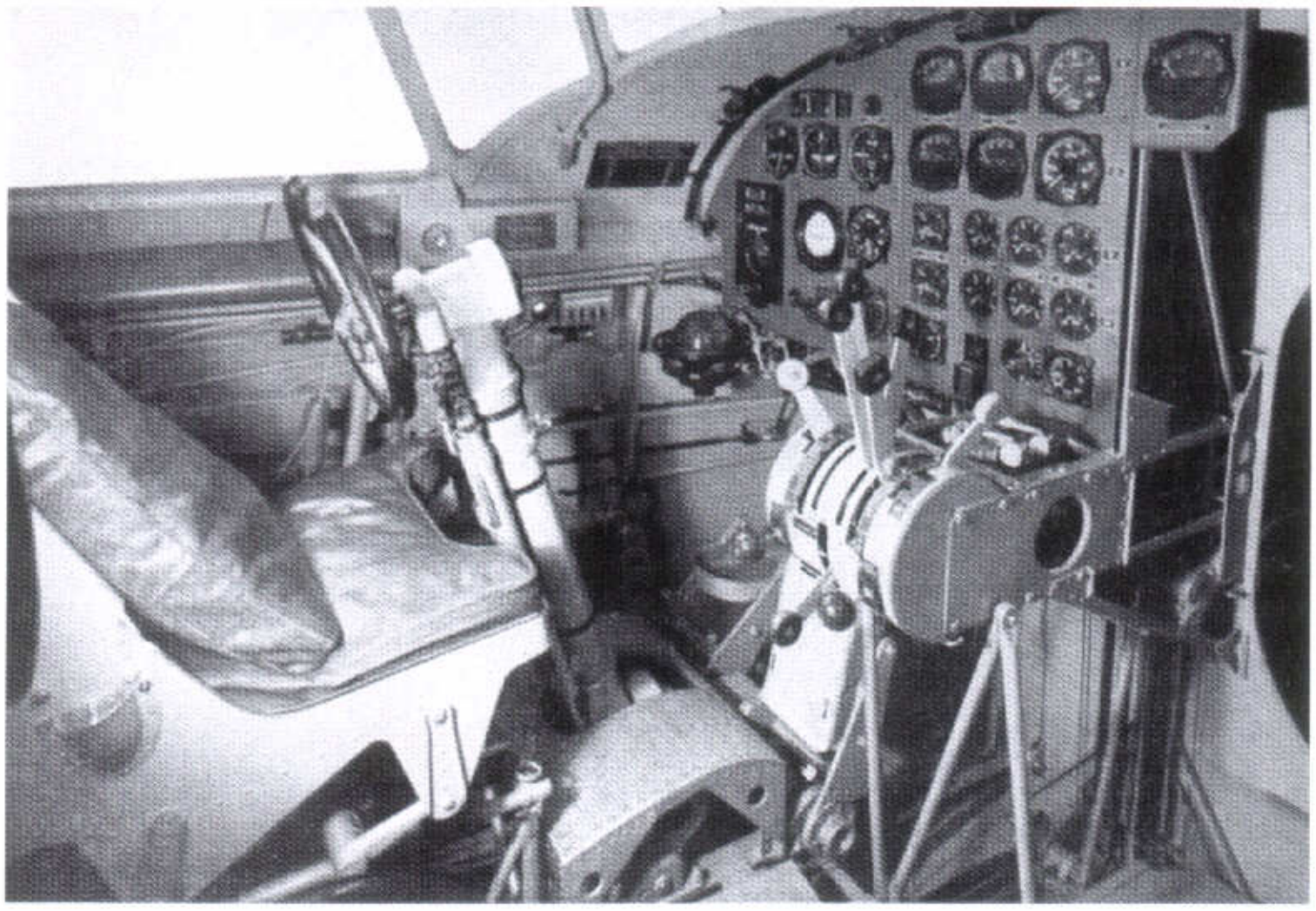
This chapter has clearly shown how interior painting of the Luftwaffe's aircraft changed over the years. When it became clear that the war would last longer than had been expected and many more aircraft would also be lost, rationalisation measures were decided to meet the increasing requirement for aeroplanes. The editions of the L.Dv 521/1 (*see pages 203, 220*) indicate how long a regulation lacquer could last and what quantities of material were consumed. In view of the fact that through the effects of the war aircraft could no longer fly as many hours as previously, interior painting of aircraft was suspended as an initial rationalisation measure. This was quite simple, since aircraft were by now made almost entirely of metal throughout, aluminium being the main material. Aluminium is by nature more resistant to corrosion. Materials based on iron, steel and magnesium continued to be surface protected on account of the corrosion risk.

Something this chapter on interior paints has made clear is what rationalisation measures were introduced. The effects on the appearance of freshly produced aircraft has never yet been so vividly described. In view of the fact that aircraft production reached its highest output as late as 1944 and never came to a stop entirely until the war ended, it is clear that we need to re-assess the paints for Luftwaffe aircraft.

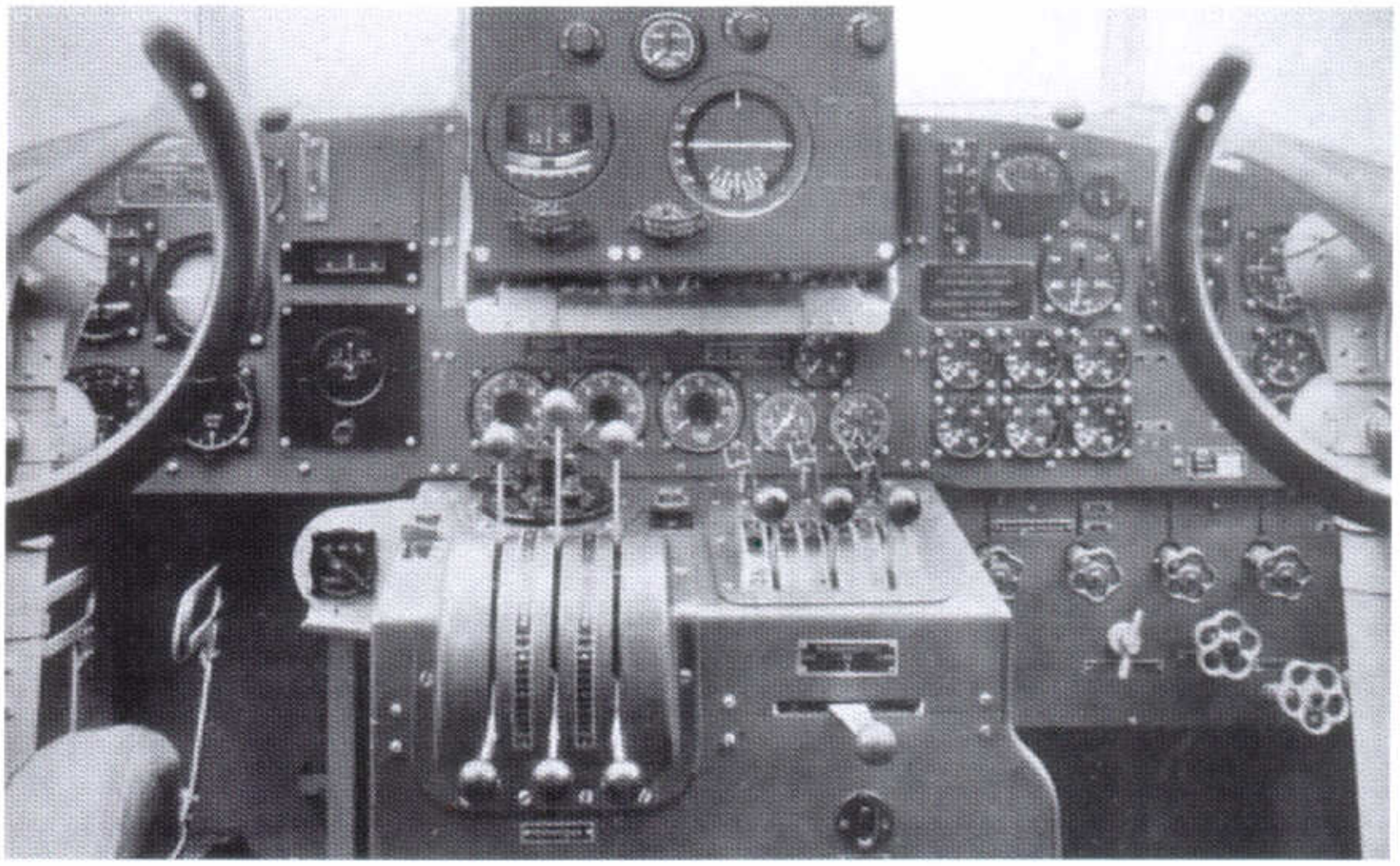
318: *The well laid out cockpit of the Dornier 26 is mostly RLM 01 Silber with the instrument panel in a medium tone. The Do 23's instrument panel was to be finished in Avionorm-Decklack Nr 702 Graumatt Nr 3850, so this may be the same colour*



319: *And this is the cockpit of the Dornier 24 with a very neat instrument layout. Finishes are mostly a light grey, except for the instrument panel which looks too light for 66. It may be 02 or another grey-green. Seat cushions are probably light tan or grey. Note the three throttle levers on the central console*

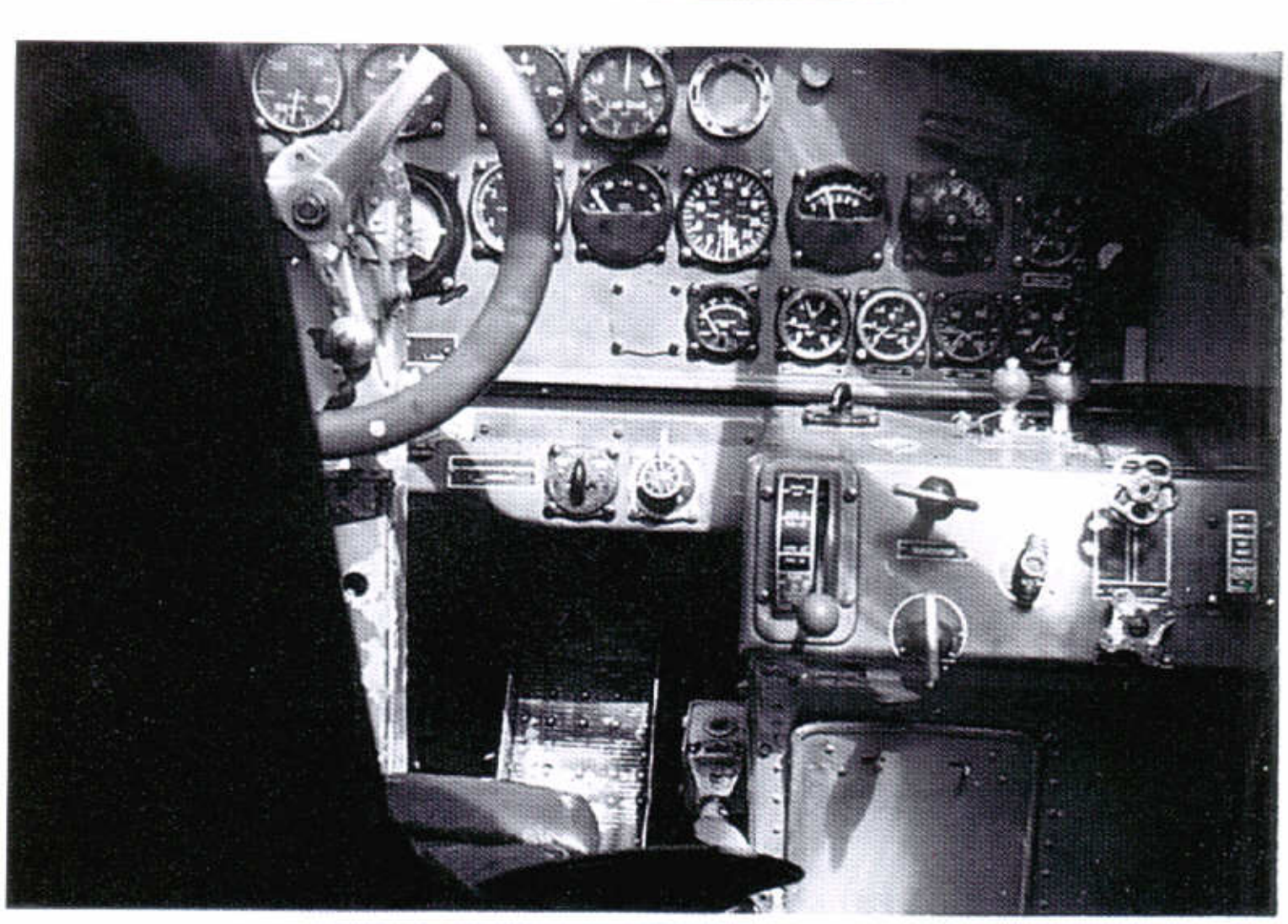


320: *One thing the Ju 52 cockpit shared with that of the Do 24 was the three throttle levers. Much of the componentry came from the same German industry suppliers—note the steering wheels and the stop cocks similar to modern day central heating accessories. Colours appear to match the Do 24: a light grey for the structure with the instrument panel in a darker grey, much lighter than the black of the instruments*



321: *The Erla type hood on this late-production Bf 109 reveals the crude welding around the windshield framing and the generally heavy construction. The rear head armour is obvious as is the extensive use of 66 as an interior finishing colour. It is obvious that the average Bf 109 pilot did not enjoy the same level of visibility as that of a P-47D or P-51D. Camouflage is 74/75/76, while the antenna mast is 70*

322: *An interior view of a Junkers W34, mostly finished in 02, in use as a navigational trainer. Note the massive handwheel used for rotating the equally enormous direction-finding loop which was a prominent feature on all Junkers W34s. The crew are wearing lightweight tan summer flying suits*

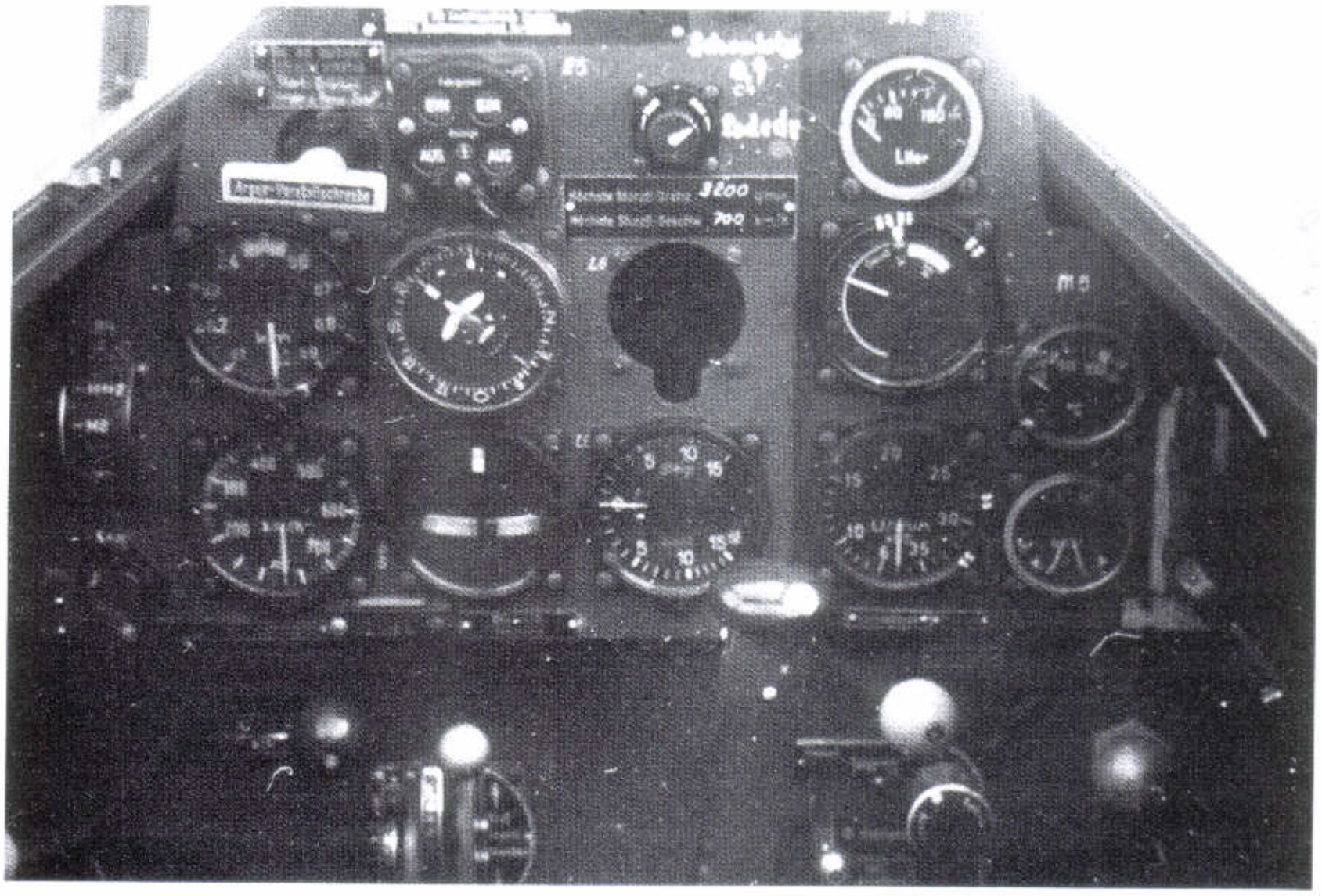


323: *This is the pilot's cockpit of a Junkers W34. The instrument panel is apparently also finished in 02. Note the rubberised rim to the steering wheel and the very neat and logical layout of the instruments*

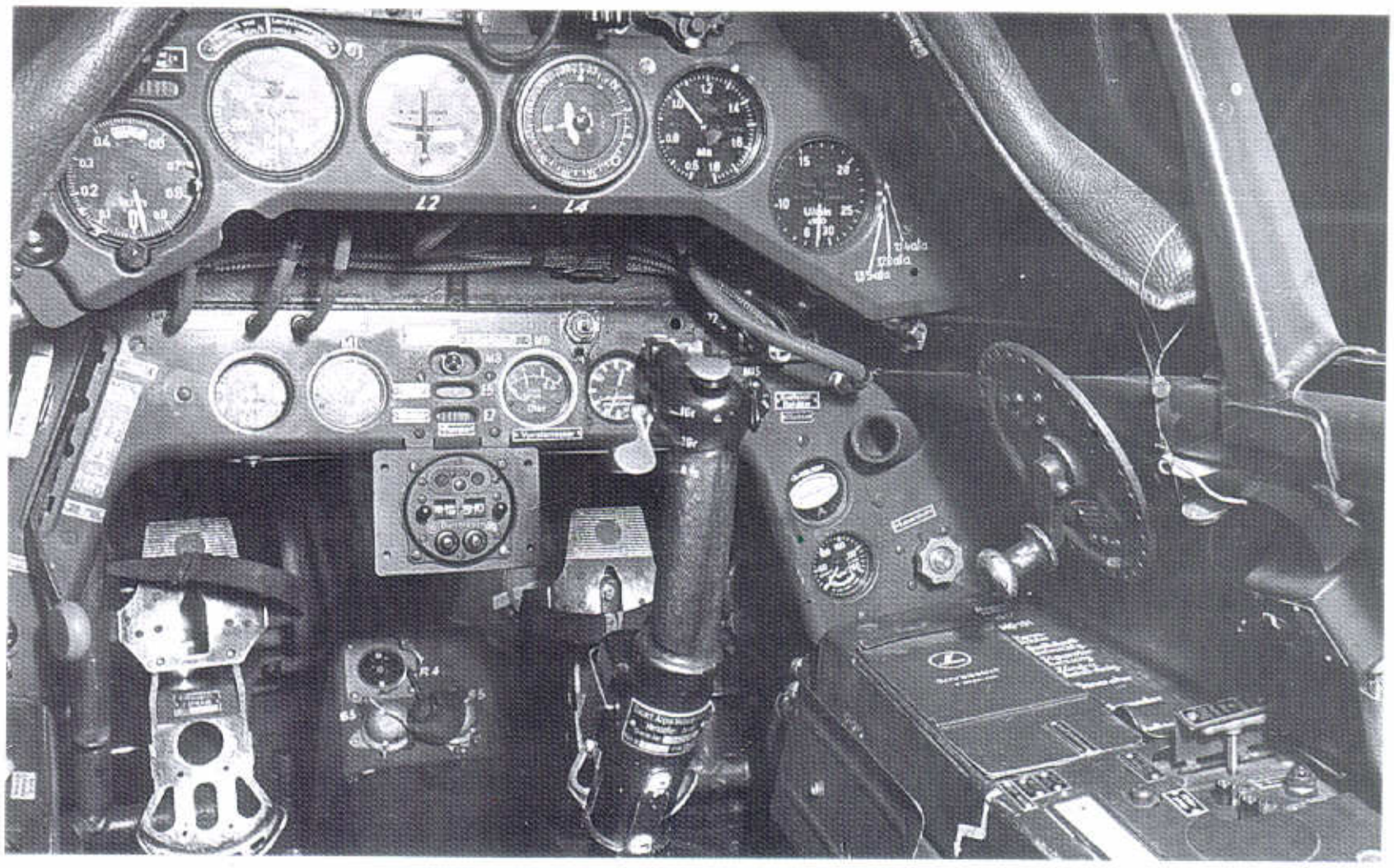
324 Above left: *The cockpit of the Arado Ar 76 is clearly mostly 66, relieved only by bright colours on the instrument bezels*

325 Above right: *The front cockpit of an Ar 96, finished as required by L.Dv 521/1 in 66. Note the turnover pylon*

326 Right: *It can be seen that the 66 colour on the instrument panel of the Arado 96 is not much different to the black of the instruments. The instrument bezels and knobs were coloured to a standard code e.g. yellow indicated fuel*



327: *Arnim Faber's very modern Fw 190A-3 cockpit greatly impressed the RAE technicians who examined it. Again, it is almost entirely finished in 66. The rudder pedals are a standard component used on several other aircraft types. Note the Focke-Wulf company logo on the starboard console*



CARING FOR AIRCRAFT PAINTWORK

In the chapter on handling fresh aviation lacquer, L.Dv 521/1 of 1938 lays down the following procedure:

"A finish specially indicated by the RLM will be applied to the ready painted aircraft before delivery to the operator or within one month after the top coat has been applied. However, the finish should be applied only after thorough, lengthy drying of the coating, if possible not less than two weeks after the coating has been applied. The finish must be applied not too thickly and rubbed down with a dry cloth in order to achieve the necessary dull surface required as effectively as possible and to avoid dust accumulating. The coating must be entirely dry in all circumstances when applying the finish."

The aviation handbook for the Dornier Do 17E can be quoted as an example of aircraft lacquer management:

"The entire aircraft will be waxed with DKH weather protection No. 5005 following acceptance.
The aircraft will be carefully dusted and the weather protection lightly rubbed on with a rag or applied with a flit spray. The weather protection will be applied so lightly that it will be enough to wipe it on with a damp rag once or twice on the paintwork. The paint should be waxed equally all over.
DKH weather protection must be stored in a warm place. If necessary, it will be raised to the right consistency by heating or thinning with DKH cleaning fluid R 50/17."

It is clear from descriptions of the finishing agents that this agent was entirely comparable with a car polish. If inexpertly applied, the painted, matt surface would undoubtedly acquire a shine contrary to the camouflage effect of the matt protective paint.

This will undoubtedly also have been reason why the circular, ref. AZ 89 (a-o) 19 No. 687/40 dated 1 February 1940 prohibited the use of paint finishes and the like for aircraft with standard paintwork. This Circular also prescribed aviation lacquer 7238.00 as a cleaning agent. Other cleaning agents such as petrol, paraffin, etc. could not be used for cleaning as they attacked the paint. The above Circular is quoted once again in Luftwaffe Regulation Sheet No. 4 of 22 April 1940. The Regulation Sheet also states:

"When a whole number of aircraft units were recently inspected at and close to the Front, it was repeatedly found that both the standard paintwork and aviation paints were being washed down with cleaning fluid and other agents.
" This must cease in future to ensure that the paintwork provides a faultless camouflage effect and in order to save on raw materials. Commanding offic-

328 Above: *Seen in Yugoslavia in spring 1943, these Bf 109G-2s of 13.(Slovak)/JG 52 gleam in the sun, their camouflage polished by the ground crews. The nearest aircraft is a tropical version, the holes left by the removal of the tropical filter stays can be clearly seen. Camouflage is 74/75/76, while the spinner is 70 with a white backplate and red, white and blue rings, the Slovak colours*

ers must immediately draw the attention of technical officers, workshop management and master painters to the above Circular and order adherence to the instructions contained in it."

The ban on cleaning aviation lacquers was also reflected in the revision of L.Dv 521/1 for the November 1941 issue. The introduction to the L.Dv lays down the following:

"In addition, the cleaning down of aircraft is prohibited (exceptions only with RLM approval, see chapter 2.2). Aviation lacquer 7238 must be used as cleaning agent for painted aircraft."

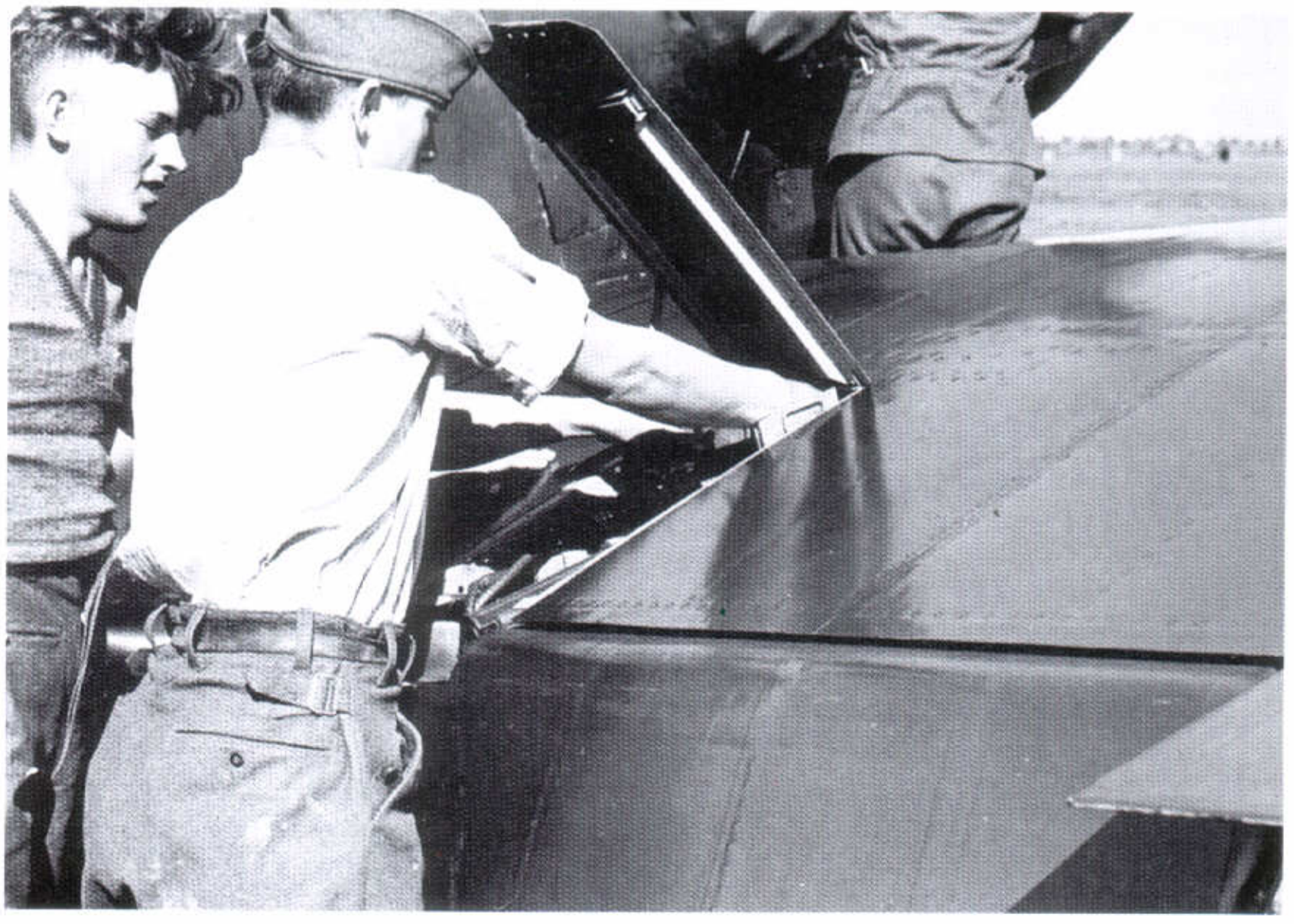
The L.Dv 521/1 1941 further prescribes:

"To ensure a dull, perfectly matt surface for the external paintwork in standard colour shades and the ensuing, indispensably low reflection values of the paint, so-called "finishing" of the ready painted aircraft is banned until further notice. Exceptions may be made only with the express approval of the RLM GL/C-E2 VII for mixed construction aircraft which are exposed to extraordinarily tight stress conditions. Generally speaking, only soiled external paintwork should be cleaned with aviation cleaning agent 7238 in accordance with the following instructions."

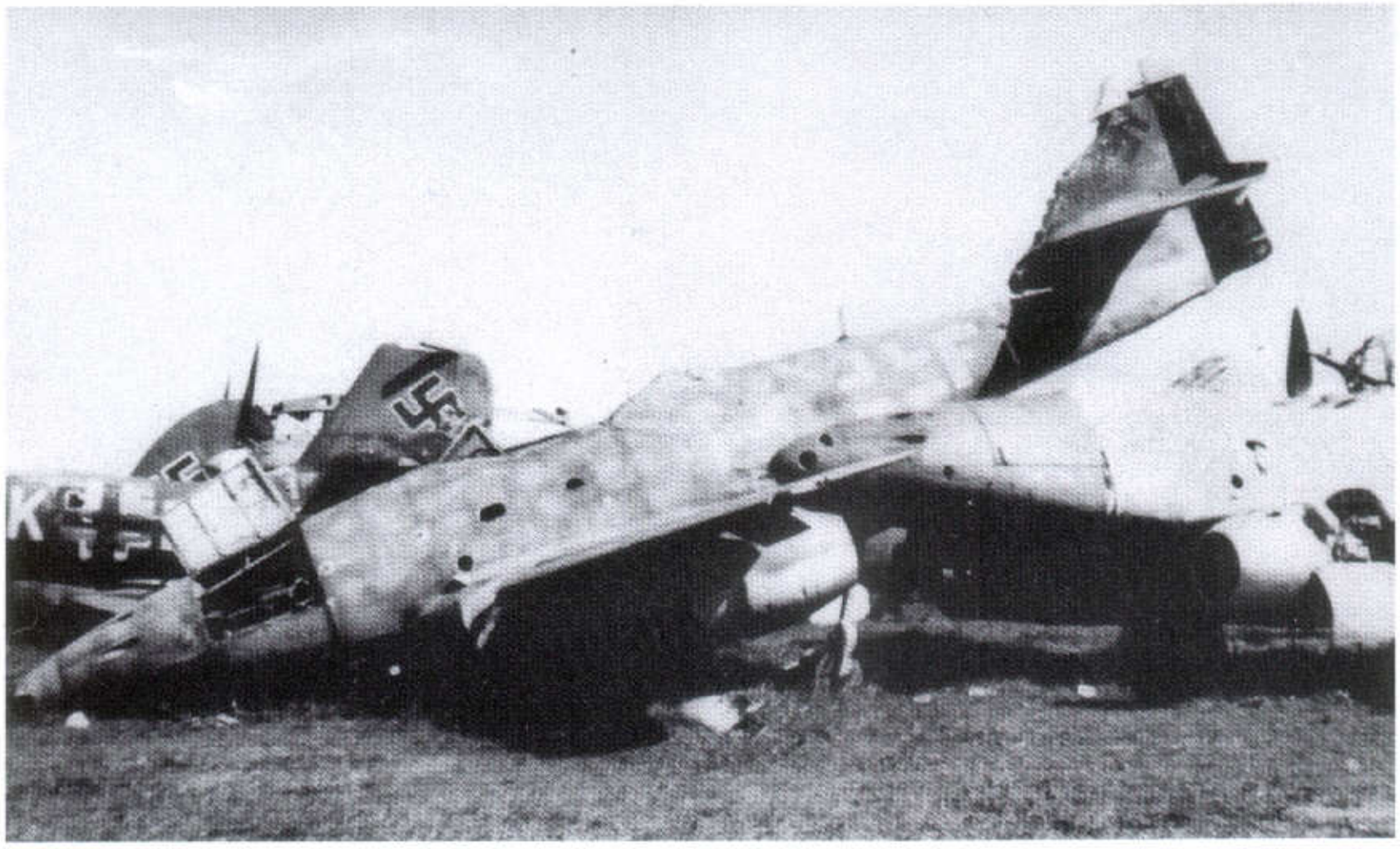
Despite this ban, the opportunity nevertheless existed for "finishing". The RLM argument was that cleaning agents were available and also produced. When we consider photos of the aircraft of Luftwaffe aces we find how clean these aeroplanes usually looked. Also evident on these aircraft was a light, silky gloss. The position with the Messerschmitt Me 163 was the same. We know of it that the paint was brought to a high gloss by applying 'Clearcote' and polish in order to reduce wind resistance as much as possible. We must therefore assume that aircraft were "finished" even during the war. What effects this had on the appearance of the aircraft colours is unfortunately difficult to say. However, this practice, too, provides an insight into a subject which has not been discussed before and which must similarly result in a re-assessment of our existing knowledge.

329 Above right: *An Fw 190A of 5./JG 3 shows off both the red 'Tatzelwurm' emblem and spinner tip of the staffel and the high polish applied to its 74/75/76 camouflage*

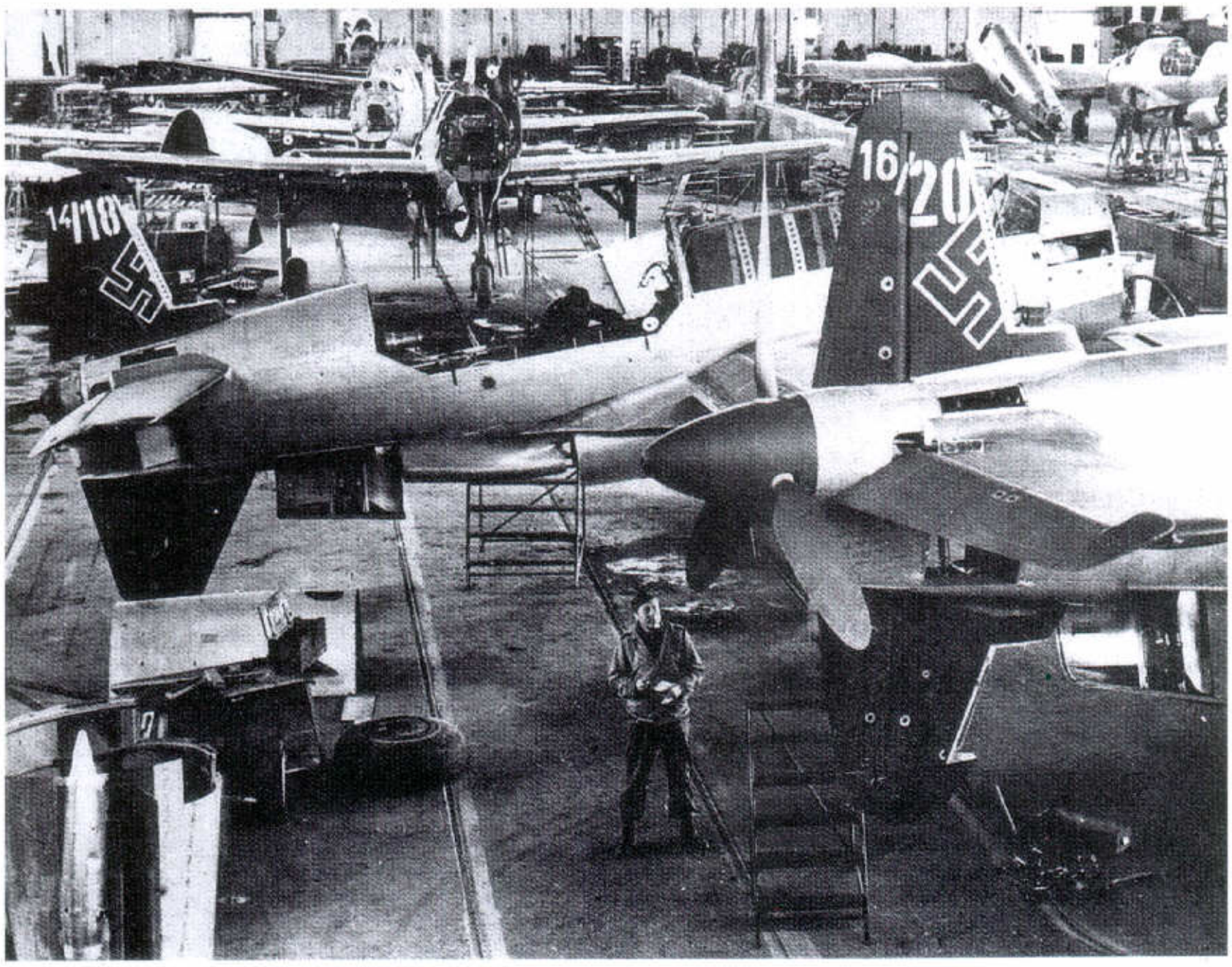
330 Right: *The extremely high gloss on the wing of this Bf 109E having its wing cannon serviced is self evident. It cannot be rain as the men are all in shirtsleeves. While the purpose of a matt camouflage is lost, the shine would have aided speed in the air, which was probably more important to the pilot than concealment on the ground, despite what the regulations said*



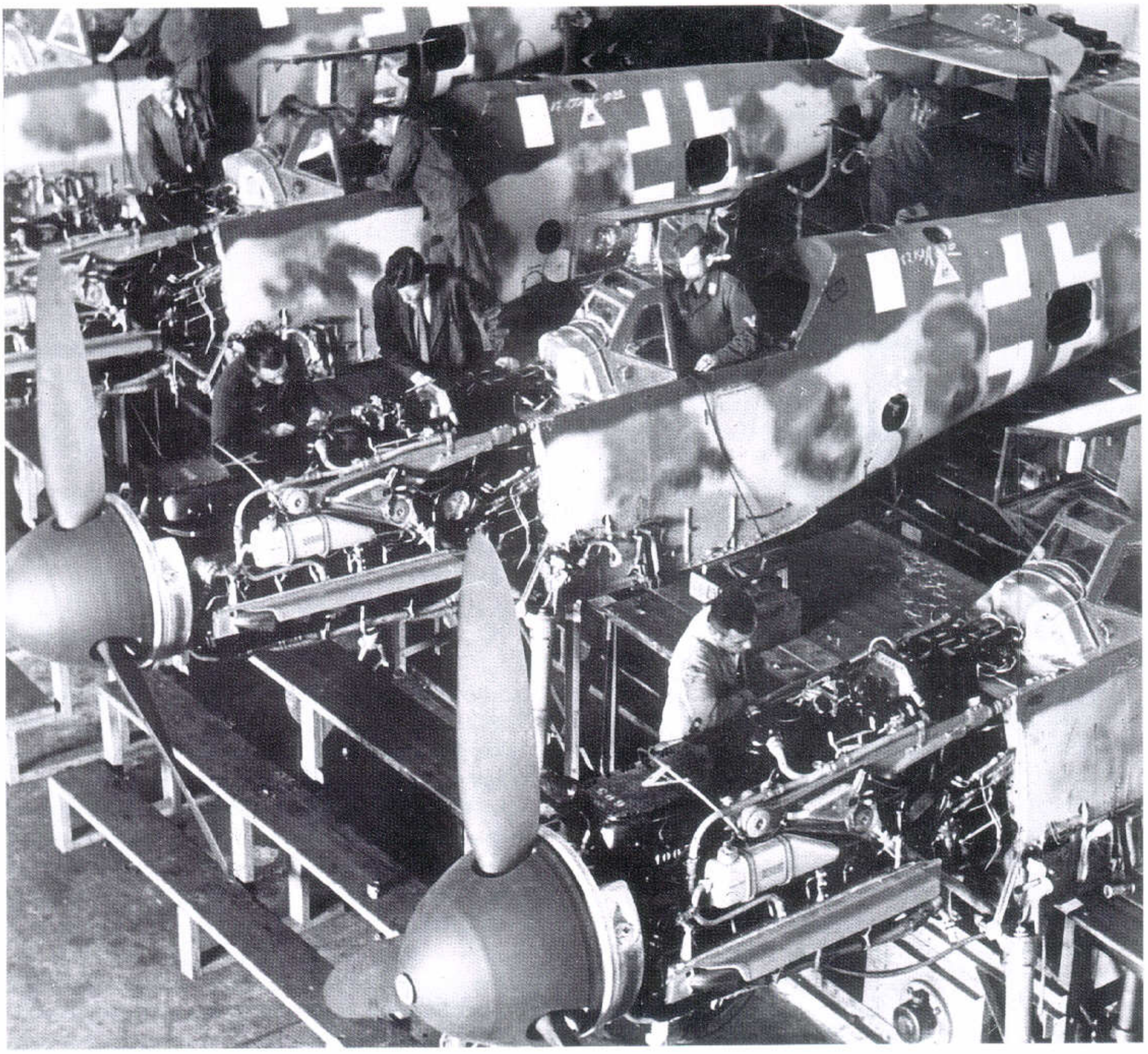
331: *An unpainted Me 262 from the closing weeks of the war is a perfect example of the surface preparation of fighters late in the war. Compare the photo with the finishing instructions for the BV 155 on page 193 and the note concerning surface putty on page 209. It is clear that every panel line was filled and sanded. The aircraft has the maximum simplified national insignia. The position of the Werknummer, 111759, is unusual*



332: *Wrecked Me 262A-2a, WNr 111685, once of 1./KG 51, whose barely discernible code, '9K+FH' can just be made out. It is apparently finished in a thinly-applied coat of RLM 82, the rudder carrying a solid coat of this colour. Overall on the fuselage are regular light blotches, possibly of 76, but more likely metal, primer and filler on joint lines showing through a very thin coat of weathered paint. Tip of the nose and fin are white, the staffel colour, to match the white 'F'. The werk nummer is some 200mm high, while the Balkenkreuz should be black against the light background*



333: *Taken at the Dornier works in Oberpfaffenhofen shortly after capture by US forces in 1945, this picture shows several B-series Dornier Do 335s. The nearest, marked 16/20, is WNr 240316, the M20. Still mostly finished in natural metal, the vertical tail surfaces are in 81, or possibly 70 if compared to the propeller spinner. The swastika is, correctly, just a white outline. Further back is 14/18, WNr 240314, the M18. Neither of these two airframes was ever completed. The intended camouflage pattern for the Do 335 series is shown on page 191*



SIMPLIFYING SURFACE PROTECTION

Back to the metal

The longer the war continued, and with the ever more difficult raw material situation, further savings in surface protection had to be made. The correspondence between the RLM and Focke-Wulf quoted in this chapter are typical examples of the measures taken. Based on the logic and known documents concerning the Bv 155 and Me 262, it may safely be assumed that all aircraft produced from mid-1944 onwards were delivered in a more or less unpainted state.

334 Above: *Messerschmitt Bf 109Gs, possibly early G-4 models in the 15000 series, in production. It is clear that the camouflage scheme is 74/75/76, in accordance with the OS-List. The large patches on the fuselage sides are typical of aircraft produced at the Erla works in 1943, which may be the location. Note that the Balkenkreuz are the maximum simplified type with the centres filled in with 75. Propellers are entirely RLM 70. By 1944 these complex finishes had had to be simplified*

"Telex RLM GL/C-E 2/III No. 10355 dated 30.6.44
To:
Messrs. Focke Wulf Flugzeugbau GmbH, Bad Eilsen
Messrs. Focke Wulf Flugzeugbau GmbH, Bremen
Test Centre Rechlin E2

Re: **Fw 190 – Discontinuing camouflage paint on aircraft undersides, large-scale trial with 50 aircraft**

With the approval of the Fighter Staff and GL/C-B 2 the following has today been determined:
In order to save labour and materials, it is planned in future to omit camouflage paint on the underside of aircraft.
As a large-scale trial 50 aircraft initially are to be produced in the new finish with only primer on the bare metal.

It is planned for the Sorau factory to carry out the work. Details will be determined on site by the representatives of the Travemünde Test Centre.
GL/C-B 2 and GL/C-E 2 are to be notified of the serial numbers of the aircraft, special reference is to be made in the machines' service records of the scrapping of the camouflage paint. In addition, a note should be included that Gen. TT and GL/C-B 2 are to be notified immediately of any complaints arising from this action. If, contrary to expectations, complaints already arise during flight-testing, then GL/C-B 2 and GL/C-E 2 are to be informed without delay."

"Telex RLM GL/C-E 2/III No. 3173 dated 14.7.44
To:
Messrs. Focke Wulf Flugzeugbau GmbH, Bad Eilsen
Messrs. Focke Wulf Flugzeugbau GmbH, Bremen

Re: **Fw 190 – Discontinuing camouflage paint on aircraft undersides, large-scale trial with 50 aircraft**

Prev.: Telex RLM GL/C-E2 /III No. 10355 dated 30.6.44
Please advise us when the first aircraft in the finish as per instructions in previous correspondence will be delivered and how much labour time and materials will be saved by this measure."

"Notification
Re: **Fw 190 – Discontinuing of camouflage paint on aircraft undersides, large-scale trial with 50 aircraft**

Prev: Telex RLM GL/C-E2 /III Nos. 10355 dated 30.6.44 and 3173 dated 14.7.44

In the above mentioned communications the RLM informs us that, with the approval of the Jägerstab and GL/C-B 2, the painting of aircraft undersides is to cease. In a large-scale trial the Sorau works will initially finish 50 aircraft with only primer on bare metal. In the service records the scrapping of camouflage paint is to be especially pointed out (quality control management please note).
We request that the Sorau works admin. advise us immediately:

1. When the first aircraft in the prescribed finish will be ready for delivery.
2. How much labour time and materials are saved per aircraft
3. The serial numbers of the aircraft.

Should any complaints arise from this measure, or complaints during flight-testing, we would request notification without delay.

Please send a reply via our courier Kubb, Focke-Wulf Bad Eilsen, with answers to the above points.
Technical field service, Bad Eilsen, dated 15.7.44"

"Distribution to:
1 x Herr Schnebel, Posen
1 x Herr Hall, stock control Posen
1 x Herr Cordes, stock control Posen
1 x Herr Becker, Contr. Gr. L., Sorau
1 x Paint shop, Posen
1 x Paint shop, Sorau
1 x Herr Oratz, material management, Sommerfeld
1 x Work study office, Sorau
1 x Works admin., Posen
1 x Works admin., Sommerfeld
1 x Herr Klemm, Detmold
2 x record files

Notification
Re: **The reduction of camouflage paint**

Further to the records memo of 11.7.44 by the Material Test Dept. (GR/Schg/-) it has today been agreed with the Travemünde Test Centre that tail surfaces preserved with dope, as well as the painted/varnished wooden components on fuselage and wing undersides, are not to be protected by silver paint as originally stipulated, but by the standard camouflage paint shade 76 as used hitherto. There is thus no need to procure special paints for this large-scale trial other than the 119D primer of Messrs. Warnecke & Böhm already specified.

It is again being stressed that the introduction of this simplification is extremely urgent and that the departments listed under Distribution are to be informed immediately of its commencement.

Sorau, 24 July 1944
Gr/Schg/-

Material Testing Dept."

"Telex – Focke-Wulf Bad Eilsen No. 1139 dated 24.7.44
To:
RLM GL/C-B 2
RLM GL/C-E 2

Re: **Fw 190 – Discontinuing camouflage paint on aircraft undersides**
Prev.: Telex RLM GL/C-E 2/III Nos. 10355 dated 30.6.44 and 3173 dated 14.7.44

In reply to the previous correspondence we can inform the Reich Ministry for Aviation that the large-scale trial with 50 Fw 190 aircraft has been initiated at our Sorau works.
Only after the aircraft have been assembled, their

components having to be delivered from our Posen works to Sorau, and only after the difficulties in procuring paint and primer have been overcome, will we be able to inform the Reich Ministry for Aviation of the aircrafts' serial numbers and the savings per aircraft in labour and materials.

Focke-Wulf, Bad Eilsen
Technical Field Service"

"1 x Herr Klemm, Detmold
Test Centre of the Luftwaffe
Dept. E 2 I
Attn. Herr Fischer

Travemünde

24.7.1944

Re: **Fw 190, discontinuing camouflage paint on aircraft undersides**

We are in receipt of your letter dated 4.7.44 and your telex dated 2.7.44 and confirm that the large-scale trial will be carried out in accordance with your directives without delay. As you informed us today by telephone, Messrs. Ruth were instructed by you a few days ago to send 100 kg of primer to us. The primer has as yet not been delivered to Sorau. Immediately upon its receipt we will forward it by courier to our Posen works where the large-scale trial is to be undertaken. In addition to the primer of Messrs. Ruth we intend to cover the bare metal with the 119D primer of Messrs. Warnecke & Böhm, which was ordered by telex on 16.7.44.

As agreed in today's telephone conversation, we will additionally camouflage with shade 76 any tail surfaces preserved with red dope, as well as the varnished wooden components on fuselage and wing undersides. We will notify you by telex when the trials in Posen commence and will forward to you as requested:

1. The serial numbers of the aircraft with simplified protection prior to delivery to GL/C-B 2
and GL/C-E 2;

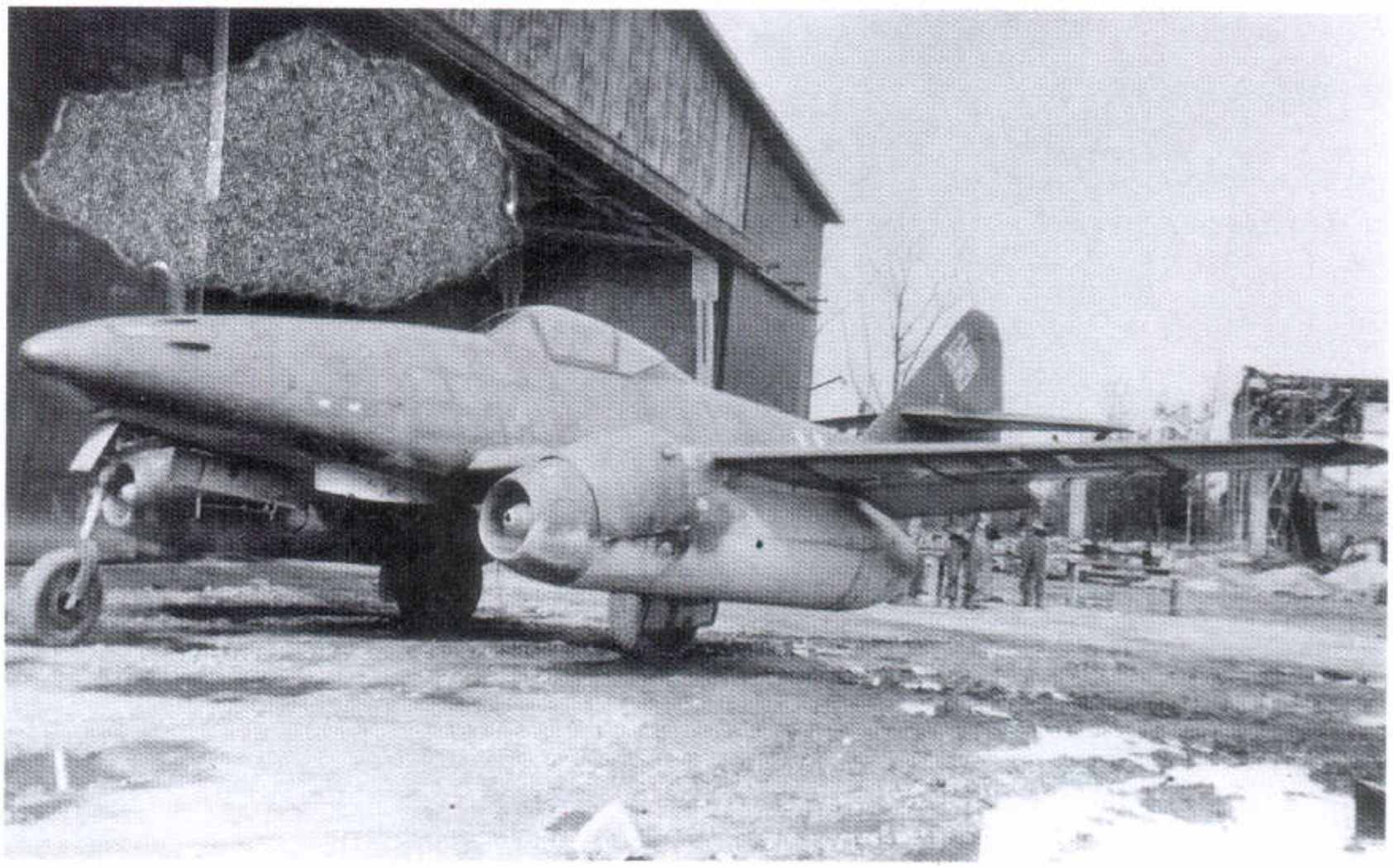
2. Especially point out in the service records the omission of a camouflage coat and add the rider that any complaints are to be notified to Gen. TT GL/C-B 2;

3. Complaints arising during production or flight-testing are also to be notified to GL/C-B 2 and GL/C-E 2;

4. Upon the completion of trials we will send you a detailed report on our operational experiences, particularly with regard to the savings in labour and materials made by this simplification.

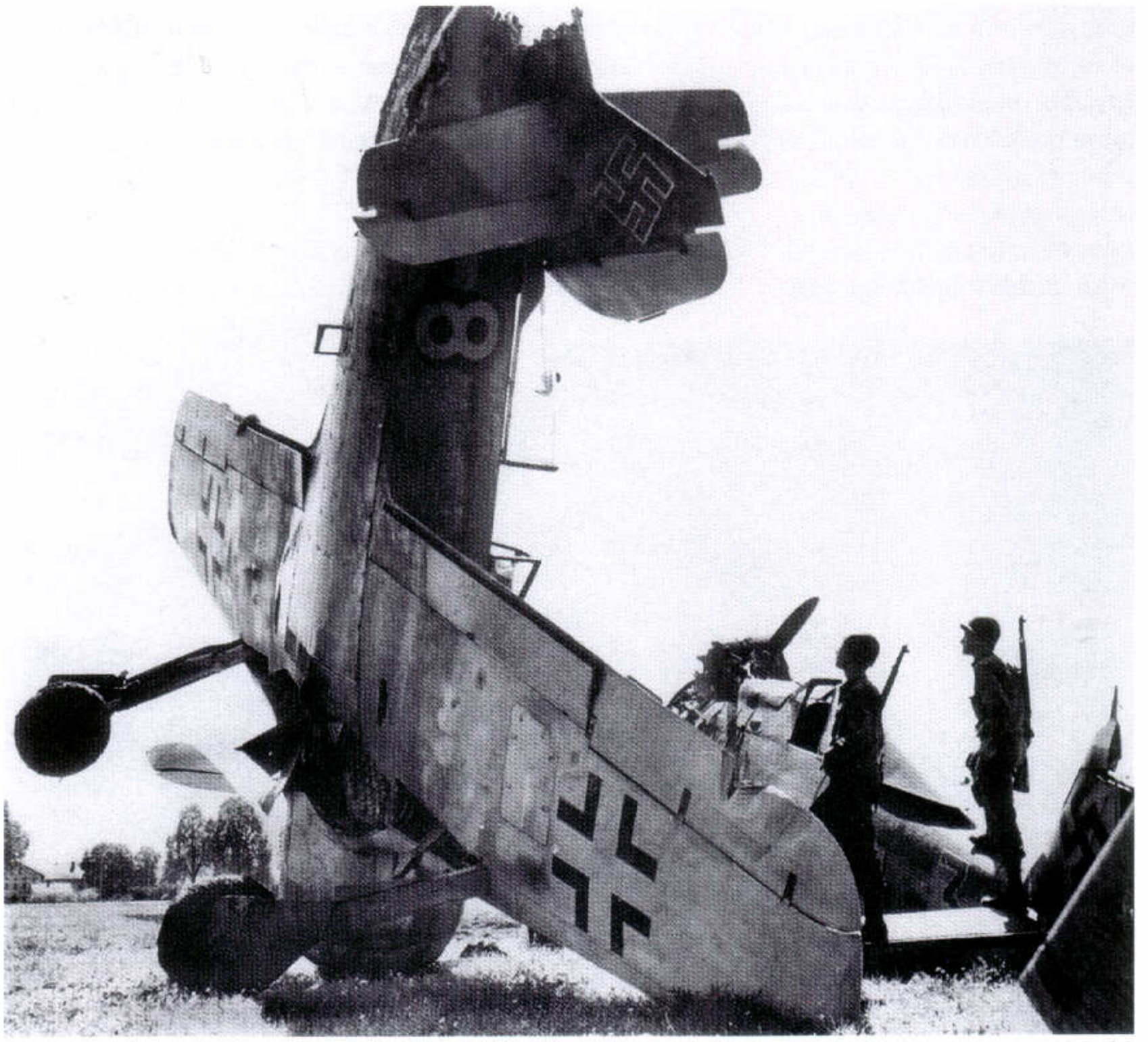
Focke-Wulf Flugzeugbau G.m.b.H."

To summarise, the correspondence reproduced here provides proof that the undersides of aircraft were unpainted. These unpainted aircraft undersides actually existed. Unfortunately it has proved very difficult to provide pictorial proof, because in contemporary photographs the unpainted undersides are almost always in shadow. The few known photos showing unpainted undersides have therefore led to some confusion. It must be assumed from the above, however, that aircraft with simplified surface protection (i.e. no paint on interior surfaces) and unpainted undersides were the rule rather than the exception.

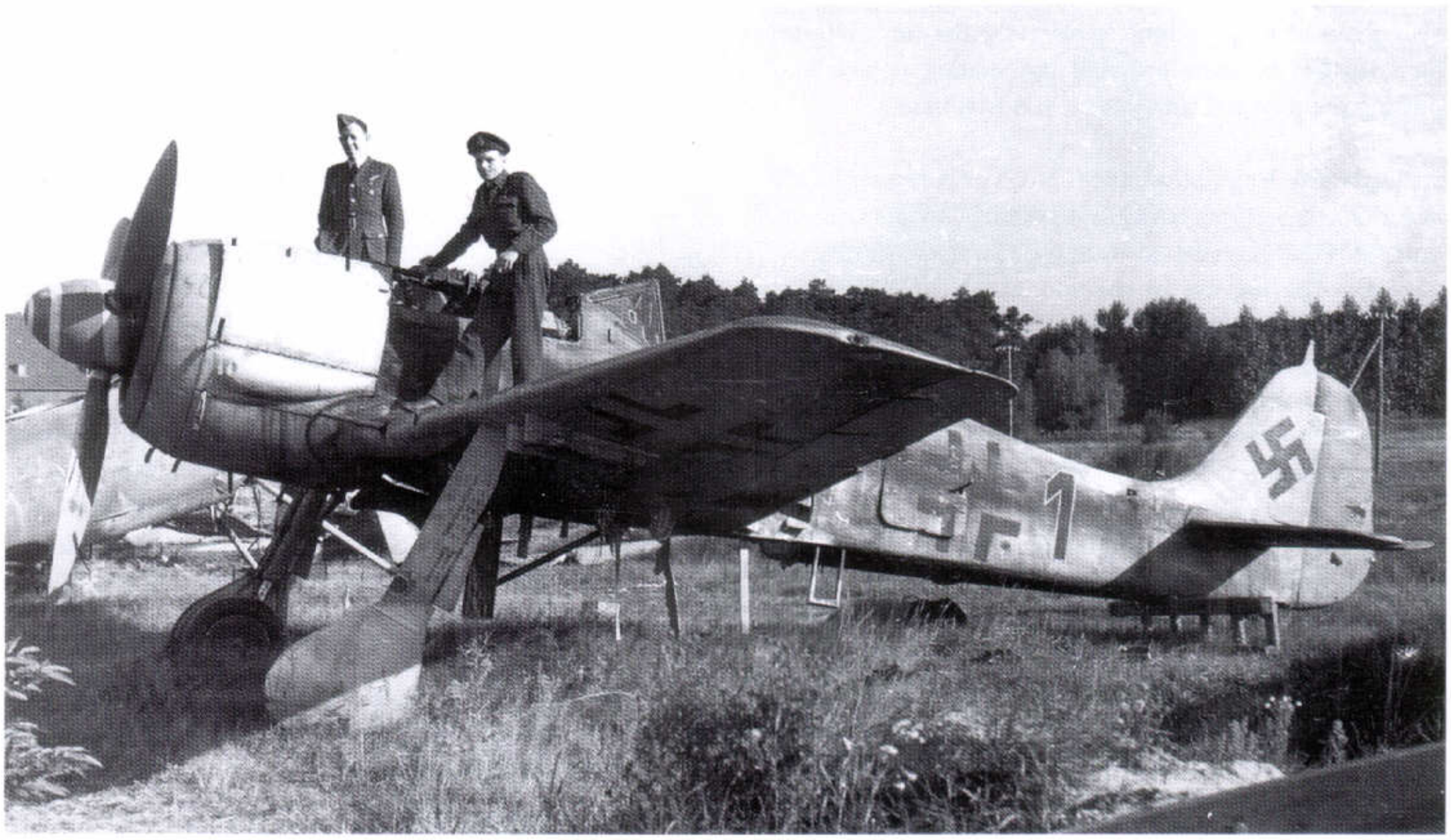


335: *This Me 262A was found at a dispersal airfield near Lechfeld in 1945. It has apparently been finished on the uppersurfaces in a very thin coat of RLM 81 or 82 which barely covers the joint filler. The engine cowlings appear to have received a better coating of 76 on the underside, while the undersurfaces of the wing are clearly unpainted. Oddly, the swastika and underwing cross appear to be the long obsolete black and white versions*

336: *This wrecked Fw 190F-8 clearly has an unpainted engine cowling which has received only minimal finishing to the rivet lines. Although the spinner has retained its white spiral, the propeller blades have been severely weathered. The very dark fuselage in the background is clearly that of an elderly biplane with a circular gun ring but the types is unidentified*



337: *An unusually finished Fw 190A-3, WNr 2168, 'White 8', which has somehow survived until 1945. Found with many other wrecks at Bad Aibling, it has apparently been completely refinished in late-war style markings and finishes. While the uppersurface pattern is probably in 74/75, the underside of the fuselage appears to be unpainted, while the wings are heavily worn 76. Why so much effort should have been expended on what was effectively an obsolescent aircraft is a mystery. Possibly it was meant for use as a Mistel component*



SHADES RLM 81, 82 AND 83

The mystery colours

These colours are still one of the greatest mysteries of Luftwaffe painting history. Experience to date indicates that these shades were introduced altogether earlier than had been assumed. RLM *Sammelmitteilung* 1 dated July 1944 includes the following passage of text:

"**Application of shades 81 and 82**.

The future introduction of the standard colours 81 and 82 instead of 70 and 71 was announced by Circular GL/C-E 10 No. 10585/43 (IVE) ref. 82b 10 of 21.8.43. The introduction of these shades is now confirmed as follows:

1) Shades 81 and 82 will be used for new aircraft patterns where shades 70 and 71 were used in the past in the light of their potential use.
2) Shades 81 and 82 should be introduced for current series instead of shades 70 and 71 at the next possible opportunity. Existing quantities of 70 and 71 will of course be used up.

Since it must be assumed that the two shades will not be uniformly used up, residues may be applied in the following combinations in order to avoid further orders of small quantities of 70 or 71:
Shade 70 (residual) + shade 82
Shade 71 (residual) + shade 81.

If, however, the residual quantity of a shade is simply too large and the transitional period up to regulation camouflage becomes too long, an attempt must be made to replace these quantities from sub-suppliers, industrial works or other aircraft factories.

3) The method of application (mottled pattern) of this new shade will not change.
4) Aircraft factories will report completion of the shade changes with the altered OS list to GL/C-E 10 IV."

The issue of the new shades 81 and 82 was therefore already announced in August 1943. Preparations for this announcement must therefore have been put in motion appreciably earlier. As has been shown in previous chapters, we must now re-date our understanding of the introduction of radical alterations. This usually means earlier. Preparations for introducing the new shades—and the emphasis is on 'shades'—already started far earlier than had been assumed in the past. While a start was already made in 1942 with rationalising the lacquer groups for aircraft, there is every possibility that thought was

338 Above: *This wrecked Fw 190F-8/R1 found at Berlin in 1945 has a very worn finish. The maximum simplified Balkenkreuz and swastika suggest that the aircraft was only thinly and partially painted in 75/83 or 81/82, most of the fuselage, cowling and undersides remaining in bare metal. Much of the fuselage is covered by exhaust staining. Apart from the 'Black 1', a tiny portion of a chevron can just be made out above the footstep. Spinner could be red*

also given a the same time to relieving the raw material base further by standardising the shades as well and putting them on a different raw material base.

Luftwaffe Regulation Sheet No. 1 of 5 January 1942 describes the serious position regarding chrome and recommends that both the Army and Luftwaffe should make the most sparing use of chrome. However, chromium oxide and chromium oxide green were important raw materials in paint production. Chromium oxide green is still one of the main pigments today for producing green colours. Withdrawal of various shades was announced in *Sammelmitteilung* 2 of 15.8.1944.

> "As a result of this realignment, the following RLM shades will be withdrawn in future: 65, 70, 71 and 74. Shade 70 remains prescribed only for air screws."

A preponderant majority of the colours listed above were green or included a large green proportion. Light blue RLM 65 was withdrawn for simplification purposes and was replaced with RLM 76. This is evident from the following instruction from Collective *Sammelmitteilung* 2 of 15 August 1944.

> "Introduction of camouflage paint Flw. 7126.76 substituting Flw. 7125.65 (cf. L.Dv 521/1 Section G.S. 41/43.
> Camouflage colour Flw. 7126.76 replaces Flw. 7125.65.
> Intended use and scope:
> The blue camouflage colour will be used to convert aircraft from permanent night camouflage to daytime camouflage."

It is evident that the few bombers remaining in the last months of the war were similarly painted with shade 76 on the underside.

Sammelmitteilung 1 of July 1944 adds further to the confusion. It contains the following passage of text:

> "**Application of shades 81 and 82.**
> Circular GL/C-E 10 No. 10585/43 (IVE) ref. 82 b 10 of 21.8.43 announced the future introduction of standard shades 81 and 82 substituting 70 and 71.
>
> The introduction of these shades is now confirmed as follows:
> 1) On new aircraft types, shades 70 and 71 which were used in the past on the basis of their function, will be replaced by shades 81 and 82."

Yet, according to L.Dv 521/1 of 1941, land aeroplanes were painted in 70/71 (cf. Chapter 8). Where is the approval for the use of colour 76 in this case? This flow of mutually inconsistent orders reveals the confusion and powerlessness of the top leadership in these last months of the war. Even though German industry was working at full spate, the end of World War II had become inevitable through the lack of direction by the top leadership.

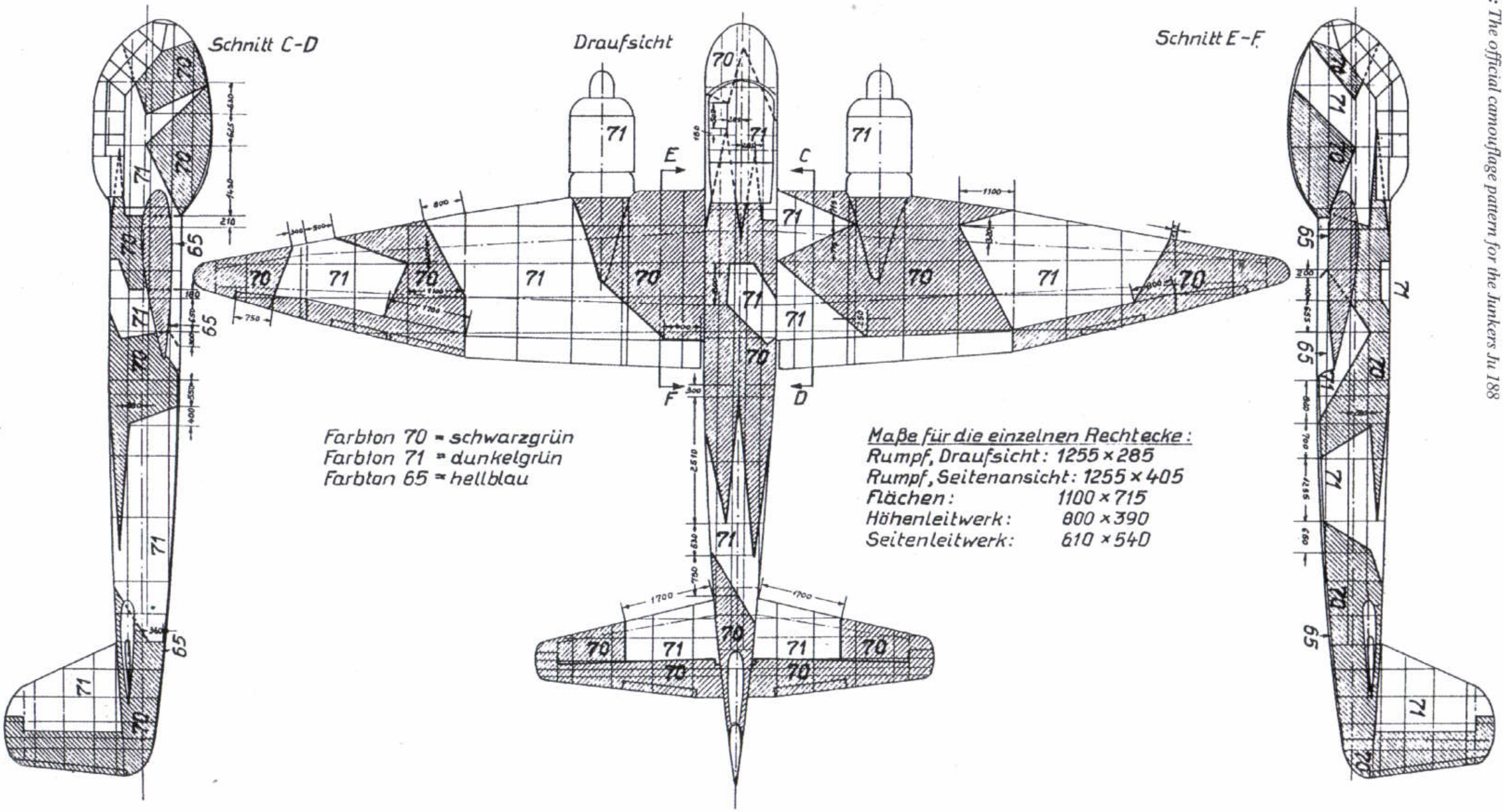
The following supplement to Amendment 10/44 for the Ju 188 shows what little regard was shown to such basic instructions concerning the removal of shades in the last months of the war:

> "The camouflage for the Ju 188 D-2 aircraft referred to in Item 8 of Amendment 10/44 cannot be converted to the new version since large quantities of paint are still available in the old shades (70 and 71). The Travemünde Command Unit has decided that the residues should first be used up. With reference to the telephone conversation with OKL Chief TLR FL.B2/H Staff Engineer Rietz of 9.10.44, the point referred to above from Amendment 10/44 is deleted. Please amend your list accordingly.
>
> Since the Ju 188 D-2 will cease in January 45, the camouflage coat will no longer be changed having regard to the existing paint supplies.
>
> The head of the Special Committee."

As a great deal has been written in the past about the shortage of fuel and its effects, a small digression to substantiate the evidence presented here is appropriate. How were paints produced at all for the air fleet in those days? Precisely what raw materials were used?

Chapter 16, *Aviation Paints*, of the 1943 edition of Hans Hadert's recipe book for the colour and paints industry contains some details and recipes for fabric dopes. These recipes are undoubtedly not entirely suitable since they were intended for fabrics but they are still considered viable as they show us how paints were produced in those days. This is all the more important as it provides evidence on how paints were produced at a late stage in the war:

> "**Aviation paint from cellulose acetate.**
> Cellulose acetate paints are particularly proof against heat and sunlight and are furthermore less flammable than ordinary cellulose nitrate paints. Paints of this kind are therefore used for coating insulation in the electrical industry and recently also for aircraft. According to P. Staudinger in Chem. Trade Journal No. 2588, page 535, 1936, a suitable paint for impregnating flying surfaces consists of:
>
> 73 kg low-viscosity cellulose acetate
> 443 kg acetone
> 216 kg alcohol
> 234 kg benzol
> 23 kg benzol alcohol
> 11 kg triphenol phosphate.
>
> The coating applied to this base may contain a pigment, preferably iron oxide or aluminium powder.


Schnitt C-D
Draufsicht
Schnitt E-F
Farbton 70 = schwarzgrün
Farbton 71 = dunkelgrün
Farbton 65 = hellblau
Maße für die einzelnen Rechtecke:
Rumpf, Draufsicht: 1255 × 285
Rumpf, Seitenansicht: 1255 × 405
Flächen: 1100 × 715
Höhenleitwerk: 800 × 390
Seitenleitwerk: 610 × 540
Junkers Flugzeug- und Motorenwerke A.-G.
Ju 188 2-Farbensichtschutz, Muster B
entspricht Zchng. S-18800-60002 vom 5. 8. 1942

Ju 188 two-colour standard finish, Pattern B

"Or
Benzol cellulose aviation lacquer
40 ccm benzol
10 ccm ethyl alcohol
20 ccm toluol
11 ccm xylol
20 ccm acetone
1 g benzyl alcohol
10 g benzyl cellulose, medium viscous
The solution will keep for one year. A little softener may usefully be added to this coating and it can be pigmented (channel black, iron oxide red, aluminium bronze)."

The salient features of the recipes:

1. Both recipes use entirely different measurement units for measuring the contents. One recipe is based on weights (kg), the other on volumetric units (cm3). It will be clear that if these paints are to be produced in larger quantities and calculation areas were made in the conversion, it is hard to say what the outcome would have been. Nor can we say what effects the absence or addition of a substitute for any one of the numerous chemicals must have had.

2. The paints were neutral without pigmentation. The pigments named were channel black, iron oxide red and aluminium bronze. There are some parallels when compared with aviation lacquer groups 20, 21 and 22 from L.Dv 521/1 of 1938. The primer for aviation lacquer group 20, for example is described as follows:

Aviation lacquer 7130. - Cellesta Nitro aviation primer red 1603 C
Red points to the pigment iron oxide red.

What effects that absence of pigment had on the colour tone of a paint is clear from the following quotation from *Sammelmitteilung* 2 of 15 August 1944:

"**Aviation lacquer 7114 (intermediate lacquer for non-flammable aviation lacquer group 05).**

Aviation lacquer 7114.01 had to be changed to Flw. 7114.99 on account of a reduced AL bronze addition. The colour is reduced to light grey as a result of the lower AL proportion. Undercoat 7114 can be ordered in future only as Flw. 7114.99.
Use and processing as for Flw 7114.01."

The aluminium bronze pigment was also mentioned in recipes for fabric dope and was used in producing silvery paints. As described above, it also served as an undercoat (or primer) for non-flammable aviation lacquers.

This very informative excursion into the technology of paints of the period and its evident traces within L.Dv 521/1 has undoubtedly succeeded in bringing this very abstract subject down to earth.

But to return to the main topic: RLM 81, 82 and 83. As indicated above, the new shades were developed as a result of saving on raw materials for aviation lacquers. The simplification and streamlining of production was of elementary importance to achieve the highest possible output.

In the course of the research for this book the *Application and Processing Instructions for RLM camouflage (buildings and ground camouflage)* of 1941 with appended colour chart were discovered. The colour chart contained the following shades:

Schwarz	Black
Dunkelbraun	Dark Brown
Dunkelgrün	Dark Green
Olivgrün	Olive Green
Ziegelrot	Brick Red
Erdgelb	Yellow Ochre
Grau	Grey

The shades Dunkelbraun, Dunkelgrün and Olivgrün show particular affinity with the still existing colour residues of RLM shades 81, 82 and 83. In an earlier work on this subject the author expressed the opinion that the similarity between the colours is so great as to lead to the belief that aircraft were painted with camouflage colours designed for buildings and ground.

In the meantime since then the opportunity of comparing the RLM camouflage colours for buildings and ground with remaining paint residues has been taken. These findings have been confirmed from Canada, Australia and Germany, and it can now be said that the

RLM shades 81, 82 and 83 were the same as RLM camouflage colours for buildings and ground.

In the absence of documentation, it was postulated in an earlier work that the aircraft were actually painted with the RLM building and ground camouflage colours. This has now proven to be not quite correct. Below follows some correspondence between Herbig-Haarhaus and the Hartwig Company concerning the finishing of flying surfaces as part of the 'Salamander Programme' (Heinkel He 162):

"**Herbig-Haarhaus AG, paints factory, Erkner Works, 29.1.1945.**
Salamander Programme 8-162
Robert Hartwig, Sonneberg.

In accordance with your discussion with our director Mr Kalkert in Erfurt, your firm was given to us as the manufacturer for the aircraft mentioned above. We have now been commissioned to provide the aviation lacquer that you require to preserve these surfaces immediately. Having regard to the countless aviation lacquers installed with yourselves under the Go 242 Programme, we have the quantities indicated below ready for immediate despatch:

Dornier Do 335

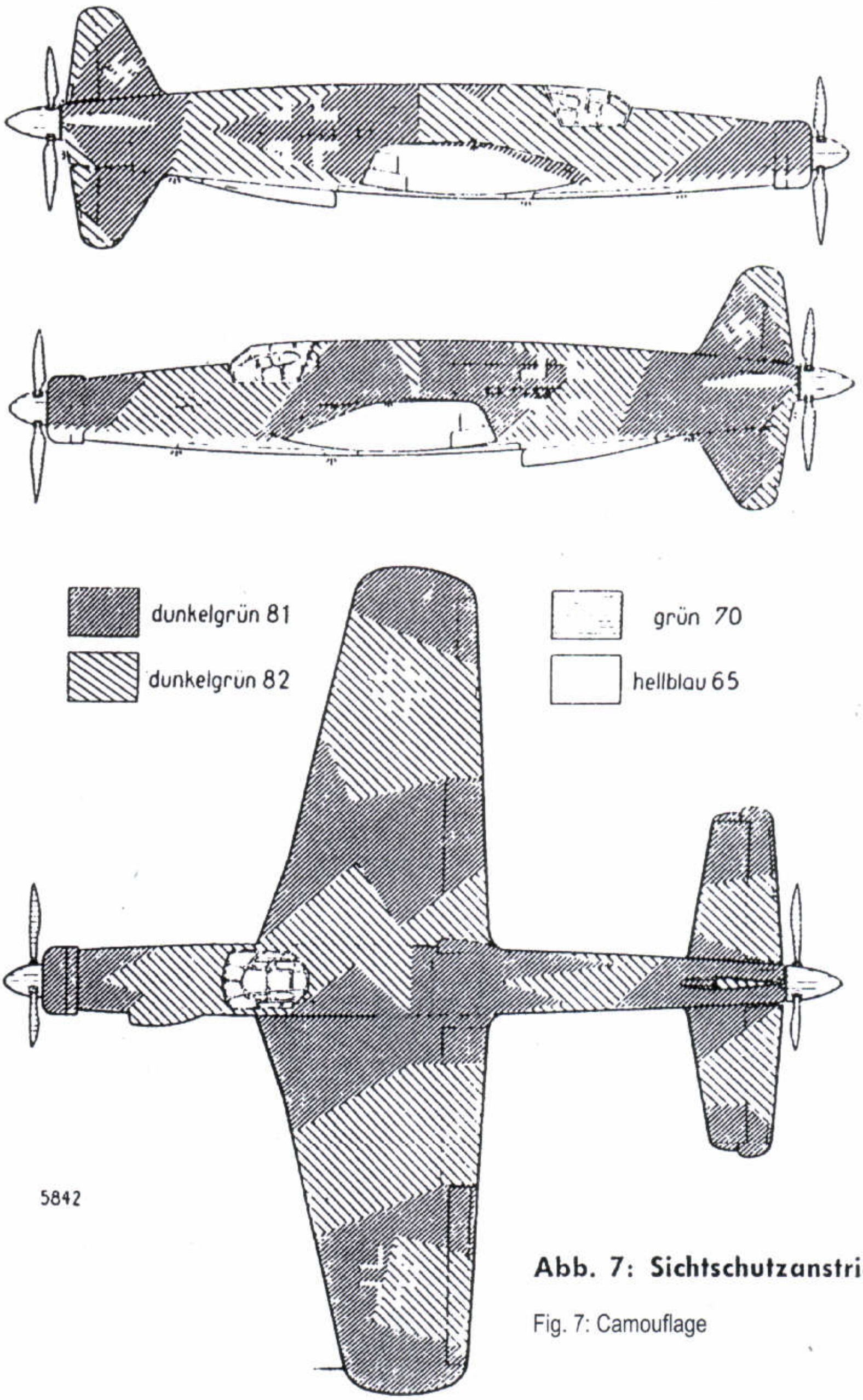


Abb. 7: Sichtschutzanstrich

Fig. 7: Camouflage

340: *The official camouflage pattern for the Dornier Do 335*

341: *The official factory camouflage pattern for the Messerschmitt Me 262 dating from 20 July 1944, showing the use of 81/82 on the uppersurfaces. Prior to this date Me 262 fighters were finished in accordance with LDv 521 in 74/75/76 colours. Just above the title box in the bottom right corner is a note stating that the underside 76 paint finish was to be used on steel and timber components only*

"100 kg	spray stopper	7216.99
20 kg	drawing stopper	7216.99
120 kg	aviation lacquer	7139.99
60 kg	aviation lacquer	7115.76
30 kg	aviation lacquer	7115.81
30 kg	aviation lacquer	7115.82
500 kg	thinner	7233.00
400 kg	thinner	7213.00
50 kg	thinner	7215.00

We have earmarked the same quantities for delivery in early February this year but with the difference that 200 kg of spray stopper 7216.99 and 40 kg of drawing stopper 7216.99 were supplied. The quantities mentioned above should cover your aviation lacquer requirement for your purposes in January/February. Please indicate your further requirement to us for March, April, May and June so that we will be able to deliver by the due date. Should you not yet have possession of the provisional preservation regulations 8-162, please obtain these immediately from Ernst Heinkel AG, Vienna Works. As already mentioned, the above quantities have been ready for despatch for some days but could not be delivered hitherto following imposition of the total blockage. We trust that the block will be lifted in the next few days and will then make every effort to arrange despatch without delay, using an express delivery consignment note.

Yours faithfully
Herbig-Haarhaus AG, Paints Factory, Erkner Works."

The aviation lacquers listed in shades 76, 81 and 82 are non-combustible top coats for aviation lacquer groups 05, 22 and 33. This makes it clear that the aircraft were not painted with RLM building and ground camouflage colours. However, there can be no doubt that the colouring pigments for both paints were identical (the paint would not otherwise have had the same colour).

That this makes sense is clear from the following communication from Luftwaffe Regulation Sheet No. 8 of 23.2.1942. It reports on the "formation of a central office for camouflage colours for the Reich and occupied territories":

"The steadily increasing use of camouflage colours for buildings and ground and the limited opportunities for producing raw materials for the production of camouflage colours means that the requirement can no longer be fully met. In order to use the available quantities of camouflage colours primarily for the more urgent purposes, a central office for camouflage colours has been set up with the Reich Minister of Aviation and Commander-in-Chief of the Luftwaffe - L. In. 13, whose task it is to plan the production and overall consumption of camouflage paints for buildings and ground within Reich territory, the Protectorate, the General Government and the Occupied Territories."

The effects of this standardisation of paints applied throughout the armed forces, since only then would the combination of all production forces make sense. Other data also show the close connection with the timings already known regarding RLM 81, 82 and 83:

- The appearance of the three late aircraft upper side camouflage paints can be fixed as summer 1944.

- Army Communication 1943 No. 181 recommends a camouflage paint of the shades olive green under the RLM colour chart (buildings and ground) and red brown RAL 8017 for a dark yellow primer.

- The supreme command of the Army (OKH) on 19 August 1944 recommended an additional camouflage paint in the colours olive green RAL 6003 and red-brown RAL 8017 for all armoured vehicles.

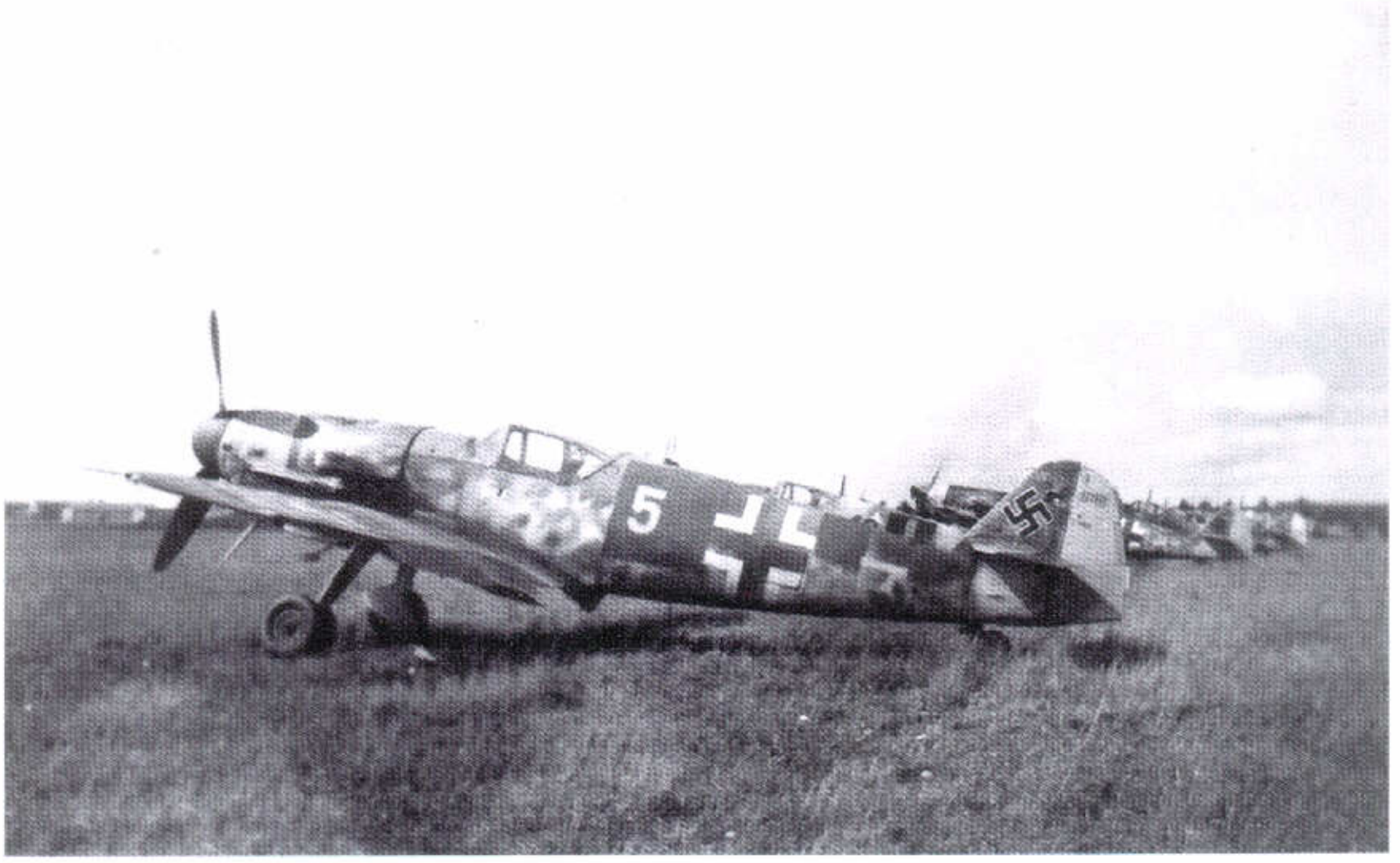
The following operational communication from Blohm & Voss of 13 September 1944 on the production of the BV 155 is the earliest document known to the author describing the use of RLM 81 and 82 by a manufacturer in connection with aircraft production (i.e. shades 81 and 82 must have been available to Blohm & Voss):

"**Re: Standard finish - camouflage for BV 155**
The Travemünde Command Unit has provided the following information:

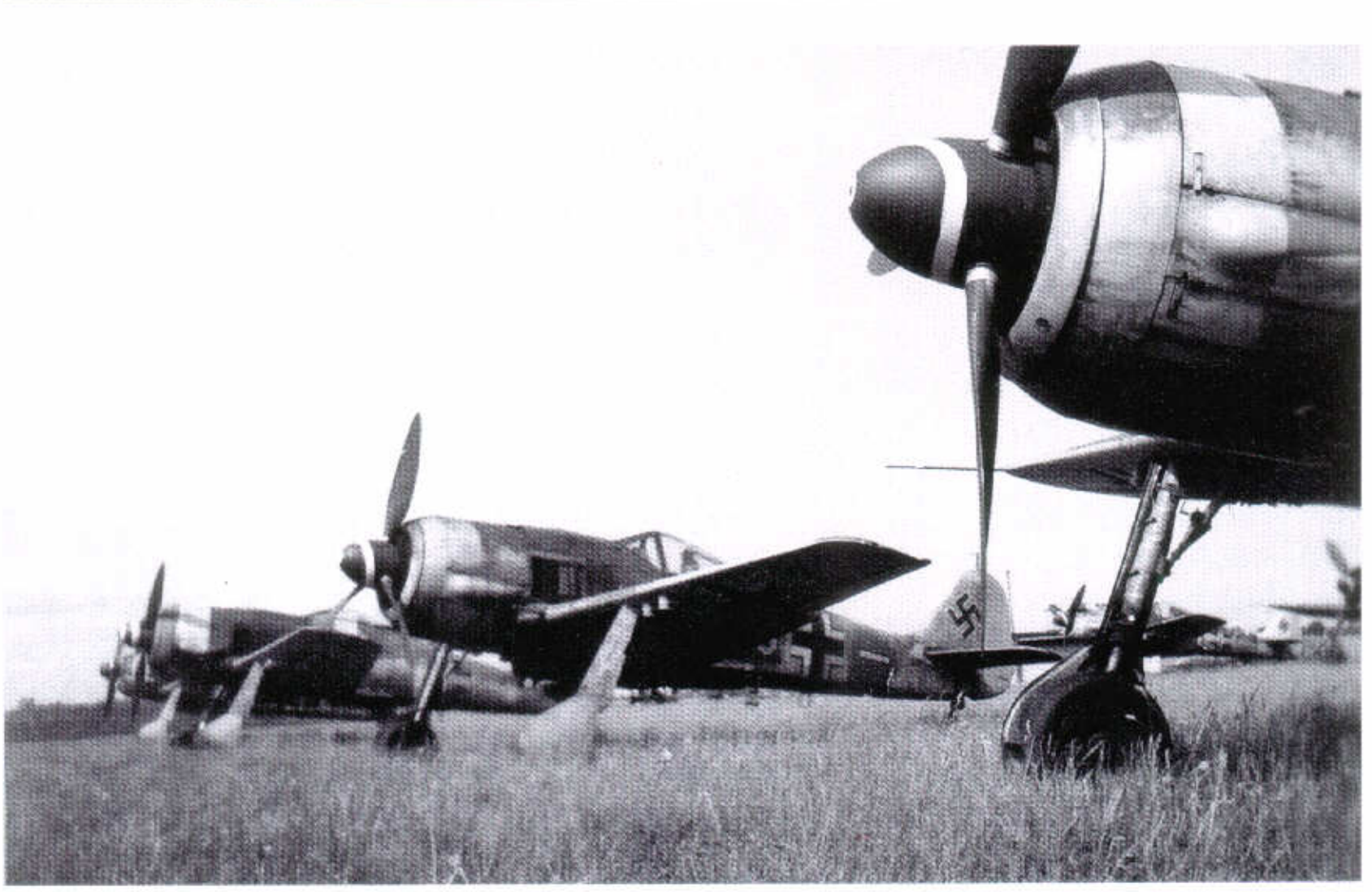
The BV 155 will receive the colours 81 Olivbraun (olive brown) and 82 Hellgrün (light green) on the upper side. Patches will be distributed in accordance with the enclosed camouflage scheme BV 109. The fuselage sides, rudder and wings—and tailplane leading edges—will be painted in shade 76 and then lightly overpainted in shades 81 and 82 mottle except for the wings and tailplane leading edges. A further simplification may be expected which will be announced to us shortly. The camouflage paint on the underside will then be omitted on the production type constructed for regular service use.
The dividing lines between the camouflage and bare metal are marked by dotted lines on the enclosed area diagram. The paint will be applied in a flowing pattern.
If stopping is used, the stopper must be applied to the bare metal (aviation stopper 7270.99), being rubbed down beyond the 'paint-bare metal' dividing line and then executed without camouflage. The paint on the underside will be omitted for economy reasons."

The above document is also remarkable from another aspect. It shows that large parts of the underside were left unpainted for economy reasons. This is therefore the last, ultimate stage in the "utmost saving of painting materials". Further particulars and the reason why aluminium can be left without surface treatments have been explained earlier.

342: *A Bf 109G-6 or G-14, probably from an unidentified training unit, painted in 74/75/76. The late style fuselage Balkenkreuz with a centre that is not filled with 75 is interesting. The aircraft has a clean appearance and this is may be a sign that the aircraft received a complete new paint job in the unit paintshop .*



343: *A Bf 109 G-10, WNr 611048, 'Yellow 5', of the third Staffel of the second Gruppe of an unknown Geschwader. It has a very interesting paint job of 75/83/76 with heavy mottling on the fuselage side, with a large repainted area where a Reich defence band would have been. The rudder (marked with 7 kills) and nose band are yellow. There is a small black '6' just forward of the rudder hinge. While the Balkenkreuze are of the simplified variety, the swastika remains in the mid-war style with a white outline*



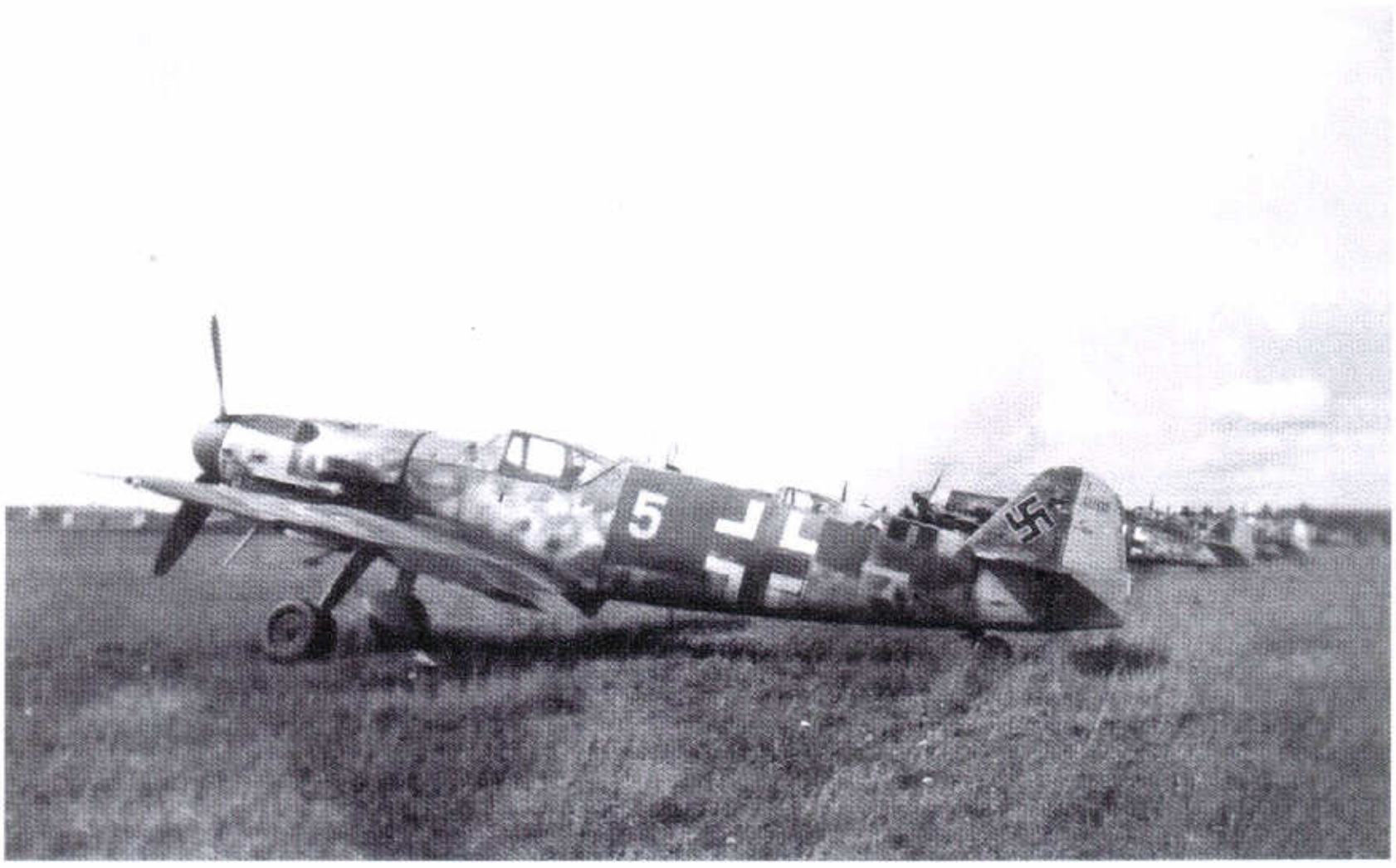
344: *Focke-Wulf Fw 190F-8/R1 ground attack fighters, every aircraft being different. A maximum simplified fuselage Balkenkreuz suggests 82 on the top of the fuselage with the darker green-grey shade of RLM 76. An 'old' cross suggests the brighter 74/75/76 finish. The nearest machine, of which just the nose is visible, carries a yellow band just behind the cowl ring. Second in line is an old machine, WNr 582384, built by Gotha. A late production version of the type can be seen in the background, which has an all-white or natural metal tail assembly. This may have served to identify a Staffel leader*

345: *A wrecked Fw 190 A-8. All visible markings are the maximum simplified type and exactly in accordance with the regulations. The spinner had a white spiral, spinner and blades were painted in RLM 70. The engine cowling is painted in a darker grey-green shade of RLM 76, the rest of the fuselage in the nearly-white version of 76. The simplified markings plus the different shades of 76 on the fuselage is a sign that the rest of the aircraft top surface was painted in 81/82*

346: *A factory-fresh Fw 190D whose dark tone suggests it is in the late-war camouflage scheme of 81/82/76. The hard colour demarcation line between upper and lower surfaces is typical for many Fw 190Ds. It is probable that only the sides of the fuselage are in 76, the rest of the undersides being left unpainted; the undercarriage fairings certainly appear to be tarnished natural metal. All markings are of the maximum simplified type and an illegible werk nummer can be seen at the base of the fin. The typical white spiral has been applied to a black spinner*

347: *A rear view of the Focke-Wulf Ta 152H-0, WNr 150003 which, judging by the tonal differences in the wing camouflage, appears to be finished in either 74/75/76 or, more likely, 75/83/76. Officially, the type should have been finished in 81/82/76. The fuselage Balkenkreuze and swastika should be in white against a dark finish*

342: *A Bf 109G-6 or G-14, probably from an unidentified training unit, painted in 74/75/76. The late style fuselage Balkenkreuz with a centre that is not filled with 75 is interesting. The aircraft has a clean appearance and this is may be a sign that the aircraft received a complete new paint job in the unit paintshop .*



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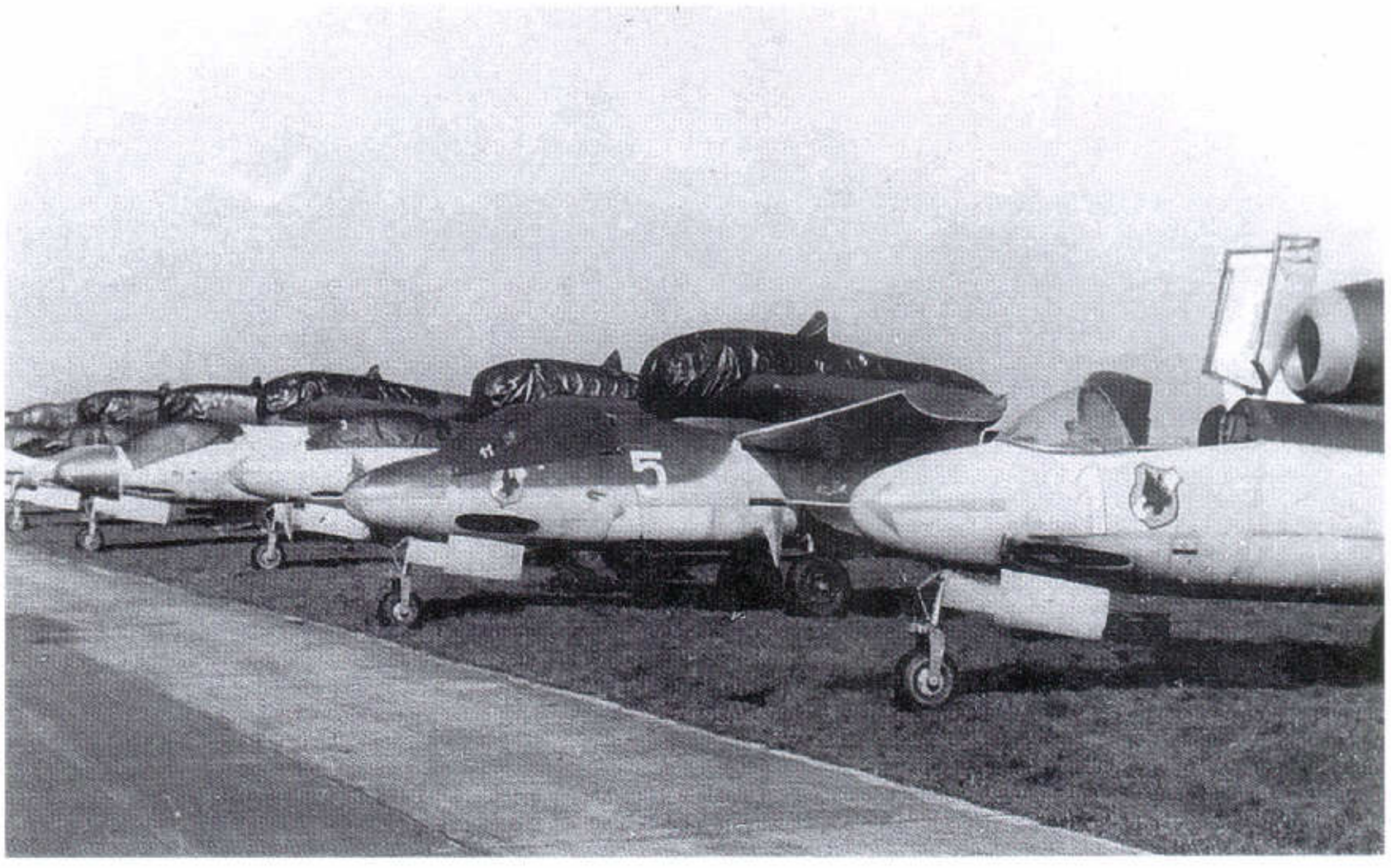
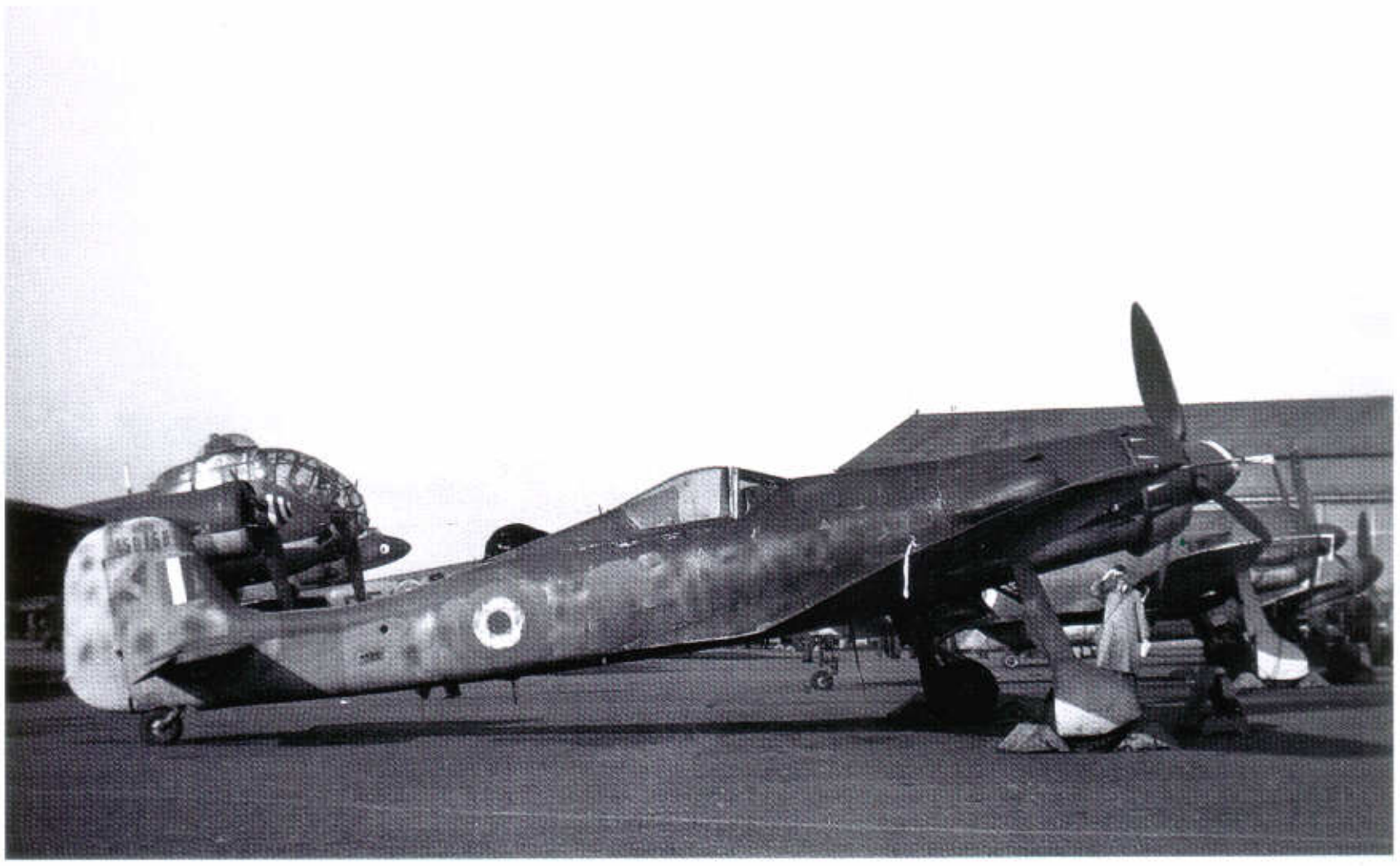


348: *A row of He 162s of 1/JG 1 at Leck on 8 May 1945. The many variations in the styles of camouflage is a sign that these aircraft were assembled from various production sources. The official camouflage scheme for the He 162 required it to be finished in 81/82/76. 'White 1' is in 81/76 with a yellow engine intake. The aircraft may have been used in combat. 'White 5' has a larger part of the fuselage painted in 81. The visible parts of the wing and engine cowling were in 82. The fourth aircraft in the row shows a partly unpainted fuselage, with no 81 around the cockpit and clearly visible putty lines with only a light coat of primer*

349: *The sixth production Ar 234C-3, WNr 250006. The official camouflage drawing for the Ar 234C dating from 19 June 1944 calls for it to be finished in 70/71/65. By the time the aircraft were finally finished, however, the two greens had officially been superseded by 81 and 82. Considering the high gloss finish, it is impossible to say from this photo which colours were used*



350: *Once flown by* Ofw *Willi Reschke of Stab./JG 301 as 'Green 9', this Ta 152H-1, WNr 150168, was captured intact and sent to Farnborough. Apart from the overpainted German markings, the aircraft remains in its original camouflage finish: 81/82/76. It appears that despite instructions to leave the undersides of fighters unpainted, the Ta 152H received a solid coat of 76 on its underside. The low tonal contrast between the two dark greens is obvious. Propeller blades are 70. When originally captured there was a Reich Defence Band in red and yellow around the rear fuselage*

There is one point which must still be discussed, namely the very different colour names used for RLM 81, 82 and 83. For RLM 81, for example, Messerschmitt used the designation brown violet, Blohm & Voss called it olive brown and Dornier dark green. Surviving photos also point to different shades on each occasion. How were these designations and the multiplicity of shades arrived at? The answer is simple and appears in L.Dv 521/1 of 1941:

> "They were produced by a number of leading paint firms under licence according to the original supplier's recipes."

Because of the war situation, every aircraft factory had its own dedicated paint manufacturer(s) who, in turn, supplied the requesting works from its own range, however good or bad it might be. There can be little doubt that there were differences in the materials supplied. Note the comments of the RAL Institute:

> "The various paint suppliers undoubtedly also supplied shades that differed from each other, so that precision of the ongoing supply of paint was very much open to question, especially when at war."

In other words, every paint manufacturer supplied its aircraft factory with the colours that it happened to be able to deliver. These problems were not helped by the inability of the RLM to issue paint charts for the colours RLM 81 and 82, as noted in *Sammelmitteilung* 1.

The same reasons also account for the application of various shades to the underside which were designated grey, grey-green or grey-blue. As the above letter from Herbig & Haarhaus indicates, there was a shortage of raw materials. Consequently the various manufacturers were obliged to 'botch up' a light blue or grey for the undersides in order to meet the requirements and obligations of the aircraft manufacturers in any way at all. Put more simply, the scarcity of raw materials means that these colours were nothing more than variations of RLM 76.

Problems encountered from the start in obtaining paints are clear from the text of Luftwaffe Regulation Sheet No. 45 of 27 October 1941. It lays down guidelines for military procurement of paints in France. It says that aviation lacquers must be obtained through Luftwaffe supply lines, while normal paints, (e.g. for accommodation and building purposes) were available and could be obtained from French paint factories. Since this was prescribed, it is clear that the French paint industry not only continued to exist but also to produce. There is every likelihood that if problems arose with the supply of aviation lacquers, the Luftwaffe could procure these from local industry as well. This is all the more probable since, as we know, the greater part of the French aviation industry had remained intact and was producing aircraft such as the Fieseler Fi 156 and Focke-Wulf FW 190 for the Luftwaffe under licence.

Examples of shades RLM 81, 82 and 83 and variations of RLM 76 are shown on the colour chart.

351: *The wreckage of a Ta 152H of Stab./JG 301, destroyed by its last owners on the airfield at Leck. The wings show the camouflage pattern well, the colours being 81/82. The very pale tone, almost white, of the 76 on the fin is obvious, while the enormous paddle-bladed propeller and the small vents on the cowling are notable details*

The following document, apparently issued by the RLM and clearly dating from before the war, is self-explanatory and is reproduced in its entirety.

Note: DVL = *Deutsche Volksliste* = German public directory

Directive for the Development of Suitable Aircraft Paints*

* Applicable in conjunction with the directives issued by the DVL

General

Principle

Paints and coatings should conform to the current state of technology. They are to be applied using the most suitable tools and in specially designated and equipped areas.

It is not permissible simply to meet the requirements by using outmoded or substandard materials and procedures, if options for exceeding said requirements are readily available.

General Information on Paints

Constituents

All constituents of the paints must originate from German raw materials. They may not contain ingredients which harm the health of workers or affect the material.

Formulae

Formulae and production methods of new paints have to be supplied to the RLM upon request. These must contain:

1) a list of subcontractors supplying ingredients for the paint system.

2) the constituents of the paint as supplied by subcontractors.

3) the intermediate compounds and their numerical composition from the suppliers' ingredients and further additives, in hundredth parts.

4) the complete formula with the composition from intermediate compounds and further additives, in hundredth parts.

5) a clear description of the production sequence for intermediate compound and paint, which would also enable the paint to be produced at another location

6) a precise specification of type and weights per kg of paint—the latter also in hundredth parts—of any materials not originating from German raw materials.

Testing and approval of paints containing non-German raw materials is dependent upon the express permission of the RLM.

7) Upon their paints having been approved, the suppliers must undertake, upon request by the RLM, to grant other paint manufacturers the right to produce their paints under a licence defined by the RLM, and to support with expert advice such companies during start-up of production.

Colour shades

1) External surfaces of aircraft:

Unless agreed otherwise, the shade for the topcoat: Grau 02

The shades of primary and intermediate coats are not specified, but they must be clearly distinguishable within the paint system so that each completed stage of the work can be verified.

Addition of aluminium bronze is only permissible for the final coat of paint, or for any coats directly covered by other coats containing bronze. The aluminium bronze powder used must be as matt as possible.

2) Internal components of aircraft:

Shade of topcoat: Grau 02

3) For the coating of pipes, markings etc. the specified standard colours, whose shades are given in the colour table, items 20 – 39, are applicable.

Paint Types

Air-drying Paints

In order to avoid the need for special equipment – paint processing and spraying rooms excepted – air-drying paints are to be given preference.

It is considered an advantage if their drying can be accelerated in drying chambers (under 100°C) without impairing their properties.

Stove Enamels

Stove enamels may not exceed a firing temperature of 100°C and a firing time of 5 hours for duralminum-type materials (aircraft material group no. 3100 – 3199); and for other metals a firing temperature of 200°C and a firing time of 2 hours.

Currently envisaged only for those components which can be easily exchanged and replaced during maintenance and which are easy to handle in the kiln (small components).

Stove enamelling must have a lifespan of at least 5 years under normal conditions.

Hot-sprayed Paint

Hot-sprayed paints must be applied in a single spraying operation, they may not heat duralminium materials (see above) above 100°C – with other metals 200°C is permissible – and must at least match the properties of air-drying paint.

Applicability of Paints:

Preparation of Materials to be Painted

1) Application of the paint must not require any cleaning other than that listed below:

2) Cleaning of metals is permissible with:

tetrachloroethylene (Dr. Alexander Wacker GmbH, München) in stationary facilities

or

P3 almeco (Henkel and Cie. AG, Düsseldorf) in stationary facilities

or

aircraft cleaner Z used manually

or

organic cleaner of the paint manufacturers used manually

Subsequent thorough drying by hand or in hot-air flow must be sufficient for ensuring surfaces suitable for the application of paint. Until further notice the use of cleaners is governed, within the framework of these specifications, by the requirements of the manufacturers.

3) Fabrics and wood do not require cleaning provided they are dust-free, clean and dry.

Storage Characteristics of Paints

1) In order to prevent sedimentation, paints must be supplied in 2 components (concentrated paint and thinner). The second component must also be the universal thinner of the paint system. The mixing ratio is to be precisely stipulated for the respective method of application. It must be possible to accomplish a perfect preparation within 30 minutes by use of stirring apparatus. The proper processing is to be tested with a paint viscometer (3mm nozzle width, 19-21°C) (manufacturer: Franz Hering Jenaer Apparatebauanstalt, Jena).

2) Paint may not develop a skin in unopened delivery containers.

3) Neither a concentrated, nor a properly prepared ready paint, may form a hard residue at the bottom.

Working Characteristics and Application Requirements of Paints

1) After proper preparation (see a and b) the paint must be perfectly suitable for spraying with a spray-gun using a 1.8-2.5mm nozzle and pressures of 3-4 bar, for dip-coating and for brushing by hand (exception: primer for fabric coverings is always brushed on!). Spraying is the normal method. It must be ensured that the flow-times in the paint viscometer as stipulated in the processing instructions are adhered to.

2) Only one thinner is permissible per paint system.

3) Climatic requirements for the paint processing areas, other than 15-30°C and a humidity other than 50-75%, are not permissible.

4) Dust-free and mist-free application of the paint is a requirement.

5) Wet-sanding or extensive dry-sanding and polishing are not permissible. Exceptions for individual aircraft are permissible if authorised by the RLM.
The necessity of having to smooth within a paint system is considered a disadvantage.

6) Specking of the paint during application under unfavourable weather conditions may not occur (temperature at, or above, 5°C, humidity at, or below, 95%). The adhesiveness of the paint so applied must be such that it will not require repainting within 3 months or 200 flying hours.

7) The number of process stages and the number of layers in a paint system should be kept as low as possible. Maximum permissible are:

for metal paints - in sheltered locations 2 coats
- in the open air 3 coats

(for metals with corrosion-resistant surfaces only one coat is permissible)

for wood varnishes/paints - in sheltered location 2 coats
- in the open air 5 coats

for fabric coverings: 6 coats

Normal application of one coat of paint:
Spraying once in a crosswise operation i.e.:
Spraying the location in question in one direction and then immediately afterwards at right angles to that direction; or, preferably, spraying the whole part first in one direction and then, after a little drying time, again at right angles.

8) With proper application the drying times required per coat are as follows:

On metal and wood:
Dust-dry after 2 hours (20 g as per B.W.)
Touch-dry after 6 hours for primer, after 4 hours for the topcoat (200 g as per B.W.)
Full curing time of the complete paintwork approx. 14 days (2000 g as per B.W.).
Furthermore, after 5 days' curing time the finished paintwork must be completely immovable when pressed for 5 seconds very hard with the palm of the hand.
Note: B.W. = testing to Bandlow-Wolf (Stoffhütte 1926 p. 988)

On fabric covering:
Touch-dry after 1 hour per paint layer.
It must be possible to apply the next coat of paint when the previous one is touch-dry. Although a reduction of the waiting time between individual paint layers is permissible, it may not be less than 10 hours, and is considered a disadvantage of the paint system.
All paint layers when touch-dry must be unaffected by the cleaning agents listed in the specification for cleaning paintwork.

9) When applying paint on a previous, touch-dry coat no mutual interaction between the colour (showing through, discolouration, leaching) may occur (national markings).

10) Paint systems, which have to be applied on top of each other, e.g. fabric covering over wing leading edge, must not have a negative effect on each other. If this

is unavoidable, then a one-coat separation paint layer must be specified. The latter will, however, be considered a disadvantage when assessing the paint system.
11) Wood and metal paintwork must be removable with paint strippers, which do not damage the base materials and do not affect the new paintwork (paraffin-free!).
12) After 48 hours the finished paintwork must normally be able to withstand the effect of any weathering without suffering damage. After 72 hours finished underwater paintwork must be able to withstand the effect of contact with salt or fresh water for 8 hours.

Properties of Finished Paintwork

Quality Characteristics in Matured Condition

Paintwork in seasoned condition, which is normally reached 1 month after applying the last coat, must (unless stated otherwise at 15-25°C) possess the following required properties:

Metal paint for above-water surface paintwork

a) Ductility of paintwork.
When applied to 1 mm thick duralminum 681 ZB 1/3 plated (aircraft material 3116), the paintwork must be able to withstand a 3 mm cupping without signs of cracks or flaking. The cupping is to be carried out in an Erichsen sheet-metal tester. (Note: If the aircraft performance sheet is changed the new material has to be used)
b) Adhesive property of paintwork.
In order to establish the adhesiveness, parallel cuts of approx. 25 mm length and spaced 2 mm apart should be made with a sharp knife in the paintwork to be tested. When cut at right angles along one side of the ends of the cuts, the tongue thus created between the layers in the paintwork must be impossible to remove with the knife.
Furthermore, after a 3 mm-cupping the paintwork may not be removable from the cupping top when rubbed with the fingertip.
c) Waterproofness
Paint applied to untreated electron metal AZM (aircraft material 3510) may not develop signs of blistering or detaching after 24-hour exposure to fresh water. Any slight softening must revert after a while without changing the paint quality. The cupping index must then be the same as before.
d) Hardness.
When thoroughly dried, it should only be possible to scrape the paint from duraluminum sheet-metal 681 ZB 1/3 plated (aircr.mat. 3116) with a thumbnail with very great difficulty. In so doing the paint must not flake off in a strip, but may at most be detached in small rolled shavings.
e) Resistance to heat
Paintwork (on dural 681 ZB 1/3 plated) must withstand heating to +70°C and cooling to -60°C, sunlight, rain and dew moisture without incurring damage. It may not be movable, must withstand a deflection with d = 70s without signs of cracking and meet the specifications for adhesive strength in Sect. 1.
D = 0; s = thickness of paint base.
f) Resistance to fuel.
Paintwork must not show signs of dissolving or blistering when a ball of tow saturated with fuel is placed on its surface for 10 minutes, this being repeated after 2 hours. Any slight swelling must disappear once the fuel has evaporated. The paintwork must fully regain its former properties.

Fuels are:

Fuel A1 (sport, training and commercial aircraft)
Octane rating 80 = aviation fuel, sel. + lead tetraethyl
Fuel A2 (for front-line aircraft)
Octane rating 87 = aviation fuel, sel. + lead tetraethyl

currently in use and

Fuel B1 (sport, training and commercial aircraft)
Octane rating 80 = aviation fuel + (20-30%) benzine
Fuel A2 (for front-line aircraft)
Octane rating 87 = aviation fuel + (50-60%) benzine

in supplementary use!

No effect may be discernible on the paintwork if it is coated for 6 hours with a semi-liquid, thick slurry of Castrol oil R and soot. The slurry layer should be applied at least 2 mm thick at a temperature of 100°C and be thoroughly rubbed off with wadding after 6 hours.

Metal paints for underwater paintwork

The requirements a, b, d, and e apply as for above-water paintwork and, in addition
c) Waterproofness.
The time of exposure to water is increased to 30 days. The requirement is that a 3% salt solution without further additives be used.
d) Resistance to fuel.
On the painted panel, tilted at 45°, 60 drops each of fuel and lubricant are dripped at 2 sec. intervals from a height of 50 cm on to one spot each. After the fuel has evaporated and the lubricant has been dried off with a rag, no changes may be discernible.

Wood varnish/paint for interior coatings

a) Ductility
The coating on a 20 mm wide, 1.2 mm thick beechwood strip must remain intact without cracks or flaking, when bent at least 3 times over a 30 mm diameter.
The outer fibres should lie in the strip's longitudinal direction.
b) Adhesive property.
In order to establish adhesiveness, parallel cuts of approx. 25 mm length and spaced 2 mm apart should

be made with a sharp knife in the coating to be tested. When cut at right angles along one side of the ends of the cuts, the tongue thus created between the cuts in the varnish/paint layers must be impossible to remove with the knife.

c) Waterproofness.

Varnish/paint applied to beech plywood, which has been triple-glued with synthetic resin, may not show any changes if exposed to fresh water for 24 hours. Any slight softening must revert after a short time. It must then be flexible again. The wood must not have been allowed to become damp. The water absorbed after 72 hours exposure is determined by weighing and is taken into consideration in the assessment.

Furthermore, the requirements d, e, f in Sect. 1 apply as for above-water paintwork.

Wood varnish/paint for exterior coatings above water

Applicable are the requirements a, b, and c as for wood varnish/paint for interior coating, f is applicable as for metal paint for above-water paintwork.

Wood varnish/paint for exterior coating under water

Applicable are the requirements a, b, and c as for wood varnish/paint for interior coating, however, the exposure time for c is increased to 30 days. The requirement is that a 3% salt solution without further additives is used.

Paint for fabric coverings

a) Ductility

When applied on linen to DIN L 21, medium grade, the paint system must provide the painted fabric with a tensile strength of 2000 kg/m.

b) Adhesive strength.

When attempting to peel off the paint layer at a fold of the fabric it must not be possible to prise off a largish piece (10x10 mm max.) of the paint layer.

c) Ductility and elasticity.

When a 200 x 200 mm piece of coated fabric is quickly crumpled and spread out again 5 times, the paintwork must not crack at 0°C.

Furthermore, by applying a pressure of at least 2.02 bar in the burst tester (Schopper Dalén), it must be possible to create a 2 mm high bulge in the painted fabric covering without cracks appearing. The test area used for this has a 100 mm dia.

d) As with metal paint for above water paintwork

e) Tensioning and stretching capacity

The paints must tension the fabric sufficiently for it to become drum-like. Testing is carried out on a standard frame using the DVL measuring bridge (PB 345). Required values are yet to be specified.

f) Adhesion capacity

The base coats must be suitable for complete adhesion of the adhesive tapes at temperatures of –5 to +30°C.

g) Non-flammability of the paintwork combined with otherwise equal properties is considered a particular advantage.

h) The requirement of resistance to fuel applies as with above-water metal paints.

i) Minimum water-permeability of the paint system is considered a particular advantage.

Paints for special requirements

These paints must meet the requirements 1 – 6 for the relevant basic material and must, in addition,be able to withstand the following stresses.

a) Acid-proof paint.

The paint must be able to withstand 24 hours direct contact with accumulator acid without changes occurring.

b) Fuel-resistant paint (not for tank interiors)

The paint must be able to withstand 24 hours direct contact with fuel without changes occurring.

Fuels are:

Fuel A1 (sport, training and commercial aircraft)
Octane rating 80 = aviation fuel, sel. + lead tetraethyl
Fuel A2 (for front-line aircraft)
Octane rating 87 = aviation fuel, sel. + lead tetraethyl

currently in use and

Fuel B1 (sport, training and commercial aircraft)
Octane rating 80 = aviation fuel + (20-30%) benzine
Fuel A2 (for front-line aircraft)
Octane rating 87 = aviation fuel + (50-60%) benzine

in supplementary use!

c) Paint for markings.

The paint must have the specified colour.

In the case of pipes or containers, it must be able to withstand 8 hours of direct contact with their contents without changes occurring.

d) Neutral wood varnish

Maximum drying time 3 hours.

When testing the resistance of a varnish to liquids, the effect of the panel edges needs to be eliminated by overtaping.

Weights of cured varnishes/paints:

Metal paint	3 coats	Normal 100g - maximum 150 g
	2 coats	Normal 80g - maximum 100 g
	1 coat	Normal 40g - maximum 50 g
Wood vanjsh/paint	5 coats	Normal 180g - maximum 200 g
	2 coats	Normal 100g - maximum 120 g
Fabric paint	6 coats	Normal 200g - maximum 220 g

At these weights the complete coating must provide perfect coverage.

Lower weights attained by coatings of equal quality are considered a distinct advantage of the paint system.

Quality Characteristics after Six-Month Weathering Trial

The results provide an indication of the lifespan.

1) The mechanical quality characteristics (cupping, bending, tension) may not be reduced by more than 20%.
2) Affectability by liquids may not have increased.
3) The adhesive strength may not have decreased.
4) After the trial period no obvious bleaching of the colours should be noticeable after treatment with paint care products. (The trial is carried out without prior use of such care products).

Lifespan of Paintwork

1) The minimum lifespan of paintwork is 2 years if dispersed in the open, or 1500 flying hours. Dispersal in hangars is rated at only half the time. Preconditions are the use of paint care products and good maintenance.
A longer lifespan is considered an advantage. An extension of the lifespan beyond 5 years is not being aimed for.
2) Only minor repairs should be required during the specified minimum lifespan of the paint (these should not exceed 15% of the paint quantity needed for complete repainting). Special loads and areas subject to constant wear and tear are not included in this assessment.
Regular use of a simple paint care product is permissible (paste for rubbing in or similar). A single application should suffice for 100 take-offs, or 2 months of bad weather conditions.

Note: The testing of paints is normally taken beyond the minimum requirements specified here to the point where the start and extent of any particular effect can be determined; this is then also taken into consideration in the paint's assessment.

Acceptance of new Paints

New paints are only considered for acceptance if their properties significantly exceed those of already approved paints. These approved paints fulfil the specifications best and, in addition to the specifications, serve as a comparison yardstick. However, a good test result does not automatically result in acceptance.

Preconditions

1. Applications for testing should be directed by the manufacturing company to the German Test Centre for Aviation, Berlin-Adlershof, which will provide more detailed information on test conditions.
2. Applications for trials of paint systems which have been tested by the DVL, or of which the manufacturer has extensive practical experience, may be sent to the Technical Office of the RLM. The trial applications must be accompanied by:
a) Precise working instructions for painting (within the framework of these specifications) including component make-up of paint system.
b) Price list of individual paints.
c) DVL test report number, or report on experiences with aircraft paintwork and results.
Trials are carried out at the discretion of the Technical Office on one or more aircraft, take at least 1 year, and are decisive in the assessment of the paint.
The paint manufacturer can be advised of the trial results. A good result is no entitlement to the paint's being used.

Supply of Samples

1. Delivery has to be in containers of the specified size and of such shape as to facilitate stirring.
2. Labels on containers should be waterproof and permanent.
3. The labelling on all containers of non-approved paints, which are being put forward for use, has to be as follows:
a) Name of manufacturing company.
b) Name and number of paint system, e.g. "Birrol, system AZFX"
(4 letters are to be selected for the paint system's designation)
c) Name, formula number and shade number of paint and thinner, e.g.: "Undercoat 1844/18 RAL"
or
"Top coat 2653/02 RLM"
d) Materials for which the paint system can be used, e.g. "(For metal and wood)"
or
"(For steel and light alloys)"
e) Date of filling.
4. The paints should be accompanied by detailed instructions on the layer construction of the paint system and on their application, which should be within the framework of these specifications.

LDv 521/1

Draft Specification of Handling and Application Instructions for Aircraft Paints 1938

Part 1

1938 Edition

The Reich Minister for Aviation.
Commander-in-Chief of the Luftwaffe

p.p.
Graf Baudissin

Berlin, 22 March 1938

Introduction to L.Dv 521/1 1938 Edition

The further development of surface treatments in recent years having regard to the general development of two and single coat paints requires a revision of L.Dv 521/1.

The present revision achieves further simplification and improvement since:

a) after existing stocks of single paints in lacquer group 01 have been used up, with the following exceptions for all metal aircraft, the internal parts are essentially painted with a single coat of aviation lacquer 7110.-, and the exterior parts with a double coat of aviation lacquer group 04;
b) prototypes provided with a single coat paint on the exterior by the manufacturer (e.g. Ju 86, Ju 87, Hs 126 etc.) are no longer finished with aviation lacquer group 01 but with group (single coat) 7110.- even when touching up or when re-painting is necessary;
c) non-flammable lacquer groups, especially for carrier-based aircraft that cannot be finished with the customary lacquers in view of their make-up are included, and
d) lacquers are prescribed in standard finishes 22, 61, 62, 63, 65, 66, 70 and 71 and in the 04 shade required for naval aircraft.

As long as paints on the colour charts are available from the supply surfaces, aircraft will be painted in these colours. Aircraft parks will order colours under this Regulation only when stocks of all paints have been used up, when the aviation depots possess no further stocks and no colours can be obtained by the balancing-up procedure. To what extent the corresponding lacquer should be used in the absence of one or more of the other colours in a lacquer group must be ascertained by the operator from L.E. through official channels. Any request by a military unit will include:

1. The colours on the existing colour charts, indicating the aircraft prototype.
2. The colours under L.Dv 521/1.

Item 1 no longer applies when all stocks have been used up.

Since the colours include important raw materials that may not be lost, all units are required to observe the following instructions. The arrangements made hitherto for procuring metal, fabric and wood paint groups and single paints from a few specified firms will be replaced in the near future by a new arrangement. The second edition of L.Dv 521/1 will permit the prescribed lacquers to be produced generally by the appropriate paint manufacturers under licence so that the aviation lacquers can then be obtained in similar quality not only from the firms at present existing but from all those licensed.

An appropriate Instruction will be published in the Luftwaffe Regulation Sheet when preliminary work has been completed.

General

Purpose of painting

a) Purpose protection: protection of the aircraft material against the disruptive effects of the weather, water and adhering substances. Increasing the working life of the aircraft.
b) Achieving an air-worthy condition of materials (fabric).
c) Enhancing aircraft recognition.

Definitions

a) Lacquer = a liquid which after application to a surface produces a resistant coat when dry.
b) Lacquering = the viable coating obtained from the processed lacquer.
c) Lacquer group = particular sequence of lacquers which when applied one after the other according to the processing instructions for the group produces a finished lacquering.

d) German raw materials = German raw materials means those that can be obtained in sufficient quantities in Germany. Raw materials which may exist in large quantities but cannot be obtained in Germany are not regarded as German raw materials.
e) Useful life = useful life means the time after which lacquering which has been maintained according to the regulations requires renovation following uninterrupted exposure to the effects of the weather. The figure is reduced by one half for time spent in the hanger.

Overview of surface protection agents

Group A	Corrosion-proof material (e.g. stainless steel)
Group B	Corrosion-inhibiting metal skin of the material (applied by plating, galvanising or a metal spray process) and additional protective paints.
Group C	Non-metallic protective coatings (chemically produced, e.g. anodising, atramentation and phosphetizing processes) and additional protective paints.
Group D	Lacquers (air-drying, stove-drying) applied to otherwise unprotected materials.

Listing of the various lacquer groups, single paints

General

The lacquers forming a lacquer group are listed below either in individual groups, together with an overview. When applied, the following rules generally and the processing regulations for the lacquer concerned must be closely followed. Lacquers and lacquer groups other than those prescribed may be used only on specific prototypes (aircraft using experimental paints, and the like) with the express prior permission of the RLM Engineering Office. The surface protection lists (OS Lists) accompanying the log book for each aircraft will be simplified with the entry to effect of these Rules.

Digit designations of lacquers and lacquer groups:

a) The lacquer groups are identified with a two-digit number. Groups for metal surfaces are numbered 01 to 19. Groups for fabric and wooden surfaces are numbered 20 to 30.
b) Lacquers are identified by four digits. Lacquer shades are designated by two digit numbers, following and separated from the four digit lacquer number by a point. For example:

Aviation lacquer	7107	02
	Lacquer designation	Shade designation

Designates: Metal lacquer RLM - Grau

Lacquer groups for aircraft operators and overhaul depots, and their application rules

NB: Metal one-coat lacquers see under single paints

Lacquer Group 01 (coloured)

(Warnecke & Böhm A.G., Berlin - Weissensee, Goethestr.)

This lacquer group can be used on all metals. It may be used only until stocks are exhausted and only on aircraft that originally received a two-coat finish (interior) and three-coat finish (exterior) (e.g. older models, Junkers W34). They may not be used as painting floats or the underwater parts of hulls.

Painting of metal parts of land aircraft:

Present designation:	Earlier designation:
Aviation lacquer 7102.-	Ikarol light metal primer green 201
Aviation lacquer 7105.02	Ikarol metal finish RLM grey 103 fJ

Author's note: This is the RLM grey finish.

Painting of exterior metal parts of land and naval aircraft and interior parts of naval aircraft

Present designation:	Earlier designation:
Aviation lacquer 7102.-	Ikarol light metal primer green 201
Aviation lacquer 7106.-	Ikarol finish grey 103/1
Aviation lacquer 7107.02	Ikarol finish RLM grey 103/2

Author's note: This is the RLM grey finish.

This group includes:
Aviation thinner 7200.00 (Ikarol uniform thinner 104/07).

Lacquer Group 02 (coloured)

(Warnecke & Böhm A.G., Berlin - Weissensee, Goethestr.)

This lacquer group is used only for painting the interiors of floats, the interiors and exteriors of flying boat hulls and float cradles.

Present designation:	Earlier designation:
Aviation lacquer 7102.-	Ikarol light metal primer green 201
Aviation lacquer 7106.-	Ikarol finish grey 103/1
Aviation lacquer 7108.02	Ikarol finish 111 (under water part)
Aviation lacquer 7107.02	Ikarol finish 103/2 (above water part)

Author's note: This is the RLM grey finish.

The same lacquer group may be used with the following changes in shade:

Present designation:	Earlier designation:
Aviation lacquer 7102.-	Ikarol light metal primer green 201
Aviation lacquer 7106.27	Ikarol finish yellow
Aviation lacquer 7108.04	Ikarol finish 1(11)

Uniformly for the underwater and above water parts of the floats.

Author's note: This is the yellow finish.

This group includes:
Aviation thinner 7200.00 (Ikarol uniform thinner 104/07).

Lacquer Group 03 (Silver)

(Warnecke & Böhm A.G., Berlin - Weissensee, Goethestr.)

This group can be used on all metal surfaces. It may not be used for painting floats or the underwater parts of hulls.

Painting of metal parts of land aircraft:

Present designation:	Earlier designation:
Aviation lacquer 7102.-	Ikarol light metal primer green 201
Aviation lacquer 7105.01	Ikarol metal finish RLM silver 103/S

Author's note: This is the silver finish.

Painting of exterior metal parts of land and naval aircraft and interior parts of naval aircraft:

Present designation:	Earlier designation:
Aviation lacquer 7102.-	Ikarol light metal primer green 201
Aviation lacquer 7106.-	Ikarol finish grey 103/1
Aviation lacquer 7107.01	Ikarol finish RLM silver 103/S

Author's note: This is the silver finish.

This group includes:
Aviation lacquer thinner 7200.00 (Uniform thinner 104/07).

Lacquer Group 04 (coloured)

(Warnecke & Böhm A.G., Berlin - Weissensee, Goethestr.)

This lacquer group replaces lacquer group 01 (if any stocks of single paints of lacquer group 01 have been used). It will be used for the exterior painting of all prototypes of land aircraft with the exception of those for which single paints are initially designated (Ju 86, Ju 87).

Present designation:	Earlier designation:
Aviation lacquer 7102.-	Ikarol light metal primer green 201
Aviation lacquer 7109.02*	Ikarol finish 133.02

* And standard finish shades 61, 62, 63, 65, 66, 70, 71 (e.g. 7109.61 or 7109.65), etc.

Author's note: These are the standard finishes.

This group includes:
Aviation thinner 7200.00 (Ikarol uniform thinner 104/07).

Lacquer Group 05 (Non-flammable)

(Warnecke & Böhm A.G., Berlin - Erkner)

This lacquer group may be used only on aircraft originally painted with the lacquers included in it (e.g. carrier-borne aircraft). Aircraft painted with this group may not be touched up with the lacquer groups indicated above, or vice versa.

Present designation:	Earlier designation:
Aviation lacquer 7113.-	Herboloid combination primer grey-green BC 6965
Aviation lacquer 7114.01	Herboloid combination undercoat silver BC 6966
Aviation lacquer 7115.02	Herboloid finish silver - matt grey 550 BC 6954

Author's note: This is RLM grey finish. Note, however, the original works designation of the lacquer, which is not grey but silver-matt grey, although the shade is designated 02 (RLM grey). This may be a colour variation which has caused confusion in present day evaluations of pictorial material and contemporary statements.

This group includes:
Aviation lacquer thinner 7213.00 (Herboloid special thinner BC 6970).

Lacquer Group 20 (Coloured)

Atlas Ago A.G., Leipzig-Mölkau.

This lacquer group is intended solely for painting aircraft fabric.

Present designation:	Earlier designation:
Aviation lacquer 7130.-	Cellesta nitro aviation primer red 1603 C
Aviation lacquer 7135.02*	Cellesta nitro aviation top coat RLM, grey 2000
Aviation lacquer 7136.00	Cellesta aviation topcoat neutral 1606

* And the standard finishes 61, 62, 63, 65, 70 and 71.

Author's note:
These are the standard finishes. Interestingly, this group lacks the finishes 22 and 66 available in the other groups.

This group includes:
Aviation lacquer thinner 7230.00 (Cellesta uniform thinner neutral 1611).

Lacquer Group 21 (Silver)

Atlas Ago A.G., Leipzig-Mölkau.
This lacquer group is intended solely for painting aviation fabric.

Present designation:	Earlier designation:
Aviation lacquer 7130.-	Cellesta nitro aviation primer red 1603 C
Aviation lacquer 7135.01	Cellesta nitro aviation top coat silver 1604

Author's note: This is the silver finish.

This group includes:
Aviation lacquer thinner 7230.00 (Cellesta uniform thinner neutral 1611).

Lacquer Group 22 (Coloured, non-flammable)

(Herbig-Haarbaus A.G., Berlin - Erkner)

This lacquer group is intended solely for doping fabric on aircraft originally treated with the same lacquers (e.g. carrier-borne aircraft Fi 167, FW 62). Lacquerings executed with this group cannot be touched up with the lacquer groups 20 and 21 indicated above or vice versa.

Present designation:	Earlier designation:
Aviation lacquer 7137.-	Herboloid priming dope red oxide BC 6509
Aviation lacquer 7115.02	Herboloid finish grey 550 BC 6954

Author's note: This is the RLM grey finish. The original manufacturer's designation of the lacquer should again be noted. Although the aviation lacquer (7115.02) is identical to that indicated in group 05, the manufacturer's original designations are different. Could this perhaps be a mistake in the draft L.Dv? Could group 05 perhaps be a silver one?
This group includes:
Aviation lacquer thinner 7213.00 (Herboloid special thinner BC 6970).
and
Aviation lacquer thinner 7215.00 (Herboloid special dispersion BC 9017)

Lacquer Group 30 (Coloured)

Atlas Ago A.G., Leipzig-Mölkau.

This lacquer group may be used only for exterior aircraft parts of wood. It may not be used on floats or hulls and consists of:

Present designation:	Earlier designation:
Aviation lacquer 7131.00	Cellesta wood primer neutral 2254
Aviation lacquer 7132.-	Cellesta wood filler grey 2070
Aviation lacquer 7135.02*	Cellesta nitro aircraft top coat RLM grey 2000
Aviation lacquer 7136.00	Cellesta aviation topcoat neutral 1606

* and the standard finishes 61, 62, 63, 65, 70 and 71.

Author's note: These are the standard finishes. Here, too, the original works designations differ although the same lacquer (7135.02) is indicated as in group 20.

This group includes:
Aviation lacquer thinner 7230.00 (Cellesta uniform thinner neutral 1611).

Lacquer Group 31 (Silver)

Atlas Ago A.G., Leipzig-Mölkau.

This lacquer group may be used only for exterior aircraft parts of wood. It may not be used on floats or hulls and consists of:

Present designation:	Earlier designation:
Aviation lacquer 7131.00	Cellesta wood primer neutral 2254
Aviation lacquer 7132.-	Cellesta wood filler grey 2070
Aviation lacquer 7135.01	Cellesta aviation topcoat silver 1604

Author's note: This is the silver finish.

This group includes:
Aviation lacquer thinner 7230.00 (Cellesta uniform thinner neutral 1611).

Lacquer Group 32 (Coloured)

(This group is composed from lacquers from various suppliers.) It may be used only for the interior and exterior painting of wooden floats and hulls.

Present designation:	Earlier designation:
A) Interior paintwork	
Aviation protective oil No. 7180.22	Tar oil varnish black (Rütgers-Werke)

B) Exterior paintwork
a) For the complete surface
Aviation protective oil

No. 7181.-	Wood protective oil Unikum V 2070: Gustav Rruth A.G., Wandsbek

b) Above water:

Aviation lacquer 7145.04	Light metal protective colour 1227: Hansa, Kiel

c) Underwater:

Aviation lacquer 7162.04	Avionorm Bitumen paint 120; Lüdicke & Co. Berlin - Wilmersdorf

Author's note: This is the yellow finish.

Lacquer Group 33 (Non-flammable)

(Herbig-Haarhaus A.G., Berlin - Erkner)

This lacquer group may be used only on the exterior wooden parts of aircraft originally preserved with the same lacquers. Lacquerings undertaken with this group cannot be finished with the above groups 30-32 or vice versa.

Present designation:	Earlier designation:
Aviation lacquer 7138.-	Herboloid pore filler neutral BC 6952
Aviation lacquer 7139.01	Herboloid undercoat, aluminium BC 6953
Aviation lacquer 7115.02	Herboloid finish grey 373 BC 6954

Author's note: This is the RLM grey finish. The original manufacturer's designation for the lacquer should again be noted. Compare with groups 05 and 22.

This group includes:
Aviation lacquer thinner 7213.00 (Herboloid special thinner BC 6970).
and
Aviation lacquer thinner 7215.00 (Herboloid - special dispersion BC 9017).

Single lacquers

Aviation lacquer 7140

For the interior and exterior painting of covered wooden parts.

Present designation:	Earlier designation:
Aviation lacquer 7140.-	Herboloid lacquer BC 6929
Aviation lacquer thinner 7233.00	Thinner for Herboloid BC 6929 Herbig - Haarhaus A.G., Berlin - Erkner

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Aviation lacquer 7160

Markings, lettering and national insignia for all surfaces

Present designation:	Earlier designation:
Aviation lacquer 7160	Bekoloid Cellulose lacquer No. 420
Aviation lacquer 7161	Bekoloid artificial resin lacquer No. 420 K
Aviation lacquer thinner 7232.00	Bekoloid celluslose thinner No. 4530
Aviation lacquer thinner 7234.00	Bekoloid artificial resin thinner No. 420 K V

available in shades 21 to 28 inclusive (see Annex 1).

(Shades 22 - 27 are the shades under DIN L 5)
(Beck, Koller und Cie GmbH, Berlin - Weissensee, Berliner Allee 154/58)

Aviation lacquer 7117.-

For painting, battery mountings and wooden and metal parts exposed to acids.

Aviation lacquer 7117.-	Ikarol acid resistant 112 (Warnecke & Böhm, Berlin, Weissensee)

This includes aviation lacquer thinner 7200.00 (uniform thinner 104/07).

Aviation lacquer 7102

For interior lacquering of welded hollow steel bodies (fuselage structure)

Aviation lacquer 7102.-	Warnecke & Böhm, Berlin Weissensee

Aviation lacquer 7136.00

For insulating fabric lacquers on metal lacquer.

Aviation lacquer No. 7136.00	Cellesta aviation topcoat, neutral No. 1606 Atlas Ago A.G. Leipzig -Mölkau

The lacquer is used exclusively for the topcoat on finished metal lacquers on which fabric is laid and painted with lacquer (wing leading edges).

Aviation sealant No. 7250

For insulating metal framework beneath fabric wrappings:
This consists of a mixture of:
30 parts by weight of Stearine
20 parts by weight of beeswax
50 parts by weight of paraffin
fused in a water bath (commercially available).

Aviation lacquer 7146.70

For painting metal air screws (dazzle protection)

Aviation lacquer 7142.-	Ikarol propeller lacquer red 135
Aviation lacquer 7146.70	Ikarol propeller lacquer black green 136
Aviation lacquer thinner 7200.00	Ikarol uniform thinner 104/07; Warnecke & Böhm A.G. Berlin Weissensee

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Aviation lacquer designation for wooden propellers

The aviation lacquer designation for lacquers earmarked for use on wooden air screws will be notified in the Luftwaffe Regulation Sheet in due course

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Aviation lacquer 7110

Warnecke & Böhm A.G., Berlin Weissensee

Single paints for metal lacquerings.
This single paint is essentially intended for interior painting of all combat aircraft (after any stocks of signal paints in lacquer group 01 have been used up) and for the exterior lacquering of aircraft which were originally lacquered with a single paint (e.g. Ju 86, Ju 87, Ju 88, Hs 126, Ju 52 as from Works No. 5971).

Present designation:	Earlier designation:
Aviation lacquer 7110.02	Ikarol single paint 232

and in shades 01, 22, 61, 62, 63, 65, 66, 70 and 71,

e.g. 7110.65 = Hellblau

7110.70 = Schwarzgrün

This lacquer includes:
Aviation lacquer thinner 7200.00 (Ikarol uniform thinner 104/07).

Aviation lacquer 7111

Special purpose single lacquer (anodising)

Aviation lacquer 7111	Warnecke & Böhm A.G., Berlin Weissensee

This lacquer may be used only for post-preservation of rivet sets on riveted anodised parts and for painting any bare metal parts used in the course of repairs on fully anodised aircraft (e.g. Ju 86, Ju 87). The lacquer is supplied in yellow gloss, more or less equivalent to the colour tone of the anodised parts.

Present designation	Earlier Designation
Aviation lacquer 7111.00 yellow gloss	Ikarol anodised lacquer 143

This includes:
Aviation lacquer thinner 7200.00 (Ikarol uniform thinner 104/07).

Aviation lacquer 7112.02

For touching up damage of minor extent to the interior paintwork of metal aircraft:

Aviation lacquer 7112.02 also in shade 01	Ikarol repair enamel 128/3 Warnecke & Böhm A.G. Berlin Weissensee

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Aviation lacquer 7118.00

Anodising bath for naval aircraft.
This lacquer may be used only for dipping or spraying (infrequent) anodised and post-sealed light metal parts for naval aircraft in standard production. It is used to strengthen corrosion proofing of anodised parts on naval aircraft and ensures substantially improved cleaning of the parts following assembly. The lacquer is supplied in a blue gloss to distinguish parts treated with it from untreated parts.

Present designation:	Earlier designation:
Aviation lacquer 7118.00	Ikarol anodising dip lacquer 138

This includes:
Aviation lacquer thinner 7200.00 (Ikarol uniform thinner 104/07).

Sealing compounds

The following compound are used to seal joints in the aircraft:

On metal aircraft
(except for floats and hulls) as weather protection for metal seams

Aviation sealing paste No. 7240	Ikarol joint seal 106
Aviation lacquer thinner 7200.00	Ikarol uniform thinner 104/07

On metal hulls and floats
For spaces not exposed to fuel flooding.

Aviation sealing binder No. 7245	6 cm cover strip No. 17060
Aviation sealing binder No. 7246	12 cm cover strip N o. 17120
Aviation sealing paste No. 7242	Viscous sealant for cover strip No. 20011
Aviation seal No. 7243	Liquid sealant for cover strip No. 20010 (Chemie Produkte GmbH, Berlin - Britz, Malsenrieder Str. 31-33)

For spaces with potential flooding with fuel

Aviation binder 7260.-* in the necessary versions, preferably 6 and 12 cm strip	Duroplast silver strip No. 157 (Warnecke & Böhm, Berlin-Weissensee)
Aviation sealing binder 7261.-*	Duroplast silver adhesive paste 50/10 B No. 158
Aviation joint paste 7262.-*	Duroplast jointing paste 50/10 C No. 161

* Use of these substances is permitted only after existing stocks of aviation binder 7255 and 7256 and aviation sealing paste 7253 have been used up.

Identification of lacquers used on aircraft

The manufacturer or maintenance workshop at the location where the aircraft data are painted on must indicate the main systems for metal, wood and fabric in brief beneath the heading "Lacquering" on the side wall of the fuselage. For example:

on production aircraft, under the painting rules:
painting date 1.7.5
metal: lacquer groups 01 and 02
wood: lacquer group 30
fabric: lacquer group 20

If assemblies are differently painted (e.g. bearing surfaces other than the fuselage), the information must be provided for each main assembly.

prototypes or experimental aircraft with finishes for testing:
lacquering: experimental
metal: Müller Isopren IROM
wood: Werner Lingnolack EDIS
fabric: Alfeld & Bauer Stoff IPAS
observe lacquering overview

Touching up will be entered up by the keeper in the aircraft log. The following will be entered:

a) repair date
b) repaired area
c) lacquer used.

The entry on the fuselage must be corrected following general overhauls. Any kind of particular behaviour of a lacquering to be noted in the log and reported to Engineering Office L C 7 VI.

Applicability of lacquer and sealing compounds by aircraft — arranged by construction type

All-metal aircraft
Land aircraft that may also be used at sea will be treated as naval aircraft.

a) supporting surfaces, control surfaces, controls and propulsion system without engine: aviation lacquer group 04 on all metals.

For silver-coloured aircraft, aviation lacquer group 03 on all metals externally. The upper side of the supporting surfaces of naval aircraft and the upper side of the upper supporting surface of double-deckers will receive a topcoat in shade 04.

b) Fuselage: aviation lacquer group 04 on all metals. For silver coloured aircraft, aviation lacquer group 03 on all metals externally. Shade 66, i.e. lacquer 7107.66 will be used on the instrument panel. A fuselage designed as a floating hull will be painted with aviation lacquer group 02 on all metals, namely lacquer 7108.02 as the topcoat for the entire underwater section to 10 cm above the highest water line, lacquer 7107.02 externally above the underwater line and lacquer 7108.01 or 02 internally. Riveted seams will be sealed with aviation binder 7245/7246 and aviation sealant 7242/7243. Spaces wetted with fuel following a leak must be sealed with aviation binder 7260 instead of binder 7245/7246. Aviation sealing paste 7261 will be used for this. Aviation jointing paste 7262 will be used for sealing or smoothing any kind of hollow space encoun-

tered in the above procedure.

c) Floats: aviation lacquer group 02 on all metals, 7106.27 being used as undercoat, 7108.04 as finish. Riveted seams will be sealed with aviation binder 7245/7246 and aviation sealant 7242/7243. Spaces that may be wetted with fuel on a leak must be sealed with aviation binder 7260 instead of aviation binder 7245/7246. Aviation sealing paste 7261 will be used for this. Otherwise proceed as for floating hulls.

Composite aircraft

a) Supporting surface, control surfaces, controls, alighting gear and propulsion system excluding engine.

Metal frame:
Aviation lacquer group 04 on all metals.
For silver coloured aircraft, aviation lacquer group 03 on all metals.

Fabric skin:
Lacquer group 20 on all fabrics. For silver aircraft, lacquer group 21 on all fabrics externally.

Wood exterior:
Lacquer group 30
For silver coloured aircraft, lacquer group 31externally.
For marine aircraft with fabric or wood encased supporting surfaces or where both materials are used, the upper side of the supporting surface and for double-deckers the upper side of the upper supporting surface will be sprayed with finish in shade 04.

Wood interiors:
Aviation lacquer 7140.

b) Fuselage: lacquer group 04 on all metals. For silver coloured aircraft, lacquer group 03 on all metals externally. Finish 7107.66 will be used for the instrument panel.

c) Floats: metal floats as for metal aircraft.
Wood floats: lacquer group 32.
Wood floats with metal skin:
Seals and externally as for metal floats, internally as for wood floats. The connection between the metal skin and the wooden frame will be sealed as for metal floats.

d) General for composite aircraft
1) Where fabric is in immediate contact with lacquered metal or wooden parts, the latter must receive one coat of lacquer 7136.00 at the contact points before the fabric is applied. If the wooden parts are treated with lacquer 7140, painting with lacquer 7136.00 may be omitted.
2) After painting and before wrapping, all ribs, struts and spars on naval aircraft must be painted with aviation seal 7250 liquefied in a water bath
a) along the bottom quarter of the fuselage and the entire end of the fuselage from the leading edge of the control surfaces to the rear,
b) the elevator unit, rudder and ailerons.
The winding tape may be applied to the tubing only after the sealant has dried.
3) Joints between fittings and their seatings and rigid butt ends facilitating entry for spray and seepage and rivet sets and fittings beneath fabric skins must be completely sealed throughout with transparent sticky tape (Degan and Kuth, Düren).

Wooden aircraft

a) Supporting surfaces, fuselage, control surfaces, rudder, controls and propulsion system excluding engine.

Metal:
Lacquer group 04 on all metals.

For silver coloured aircraft, lacquer group 03 on all metals externally
Fabric:
Lacquer group 20. For silver aircraft, lacquer group 31externally.
Wood:
Lacquer group 30 externally

For silver coloured aircraft, lacquer group 21.
Interior: aviation lacquer 7140.

b) Floats: as for composite aircraft.

c) General for wooden aircraft.
Where fabric is in direct contact with metal or wooden parts, the latter must be treated with lacquer 7136.00 at the contact points before the fabric is applied. If wooden parts have been treated with aviation lacquer 7140, aviation lacquer 7136.00 need not be applied.

d) For wooden naval aircraft, the upper surfaces of the supporting structure will be painted as indicated under 2 (b).

Common to all aircraft

a) Light metal tubing and welded steel tubing will be coated with aviation lacquer 7102.

b) Aviation sealing paste 7240 will be used for sealing riveted joints on land aircraft for weather protection and moisture proofing.

c) Moving surfaces (i.e. surfaces intended to move across each other) will be lubricated as directed and not painted, or if not indicated, an acid-free grease will be applied (e.g. high pressure red grease from Shell). Moving surfaces may be separated from painted surfaces with a red line 3 mm wide (aviation

lacquer 7160.28). Walkable areas will be separated from non-walkable areas by a red line 40mm wide (aviation lacquer 7160.28) and marked with a red legend "Don't walk" (50 mm high) readable from the walkable area.

d) Bracing wires, cables and control wires will be painted as for the other metals, red marking of the thread ends being unnecessary.

e) Spliced cable ends will be dipped in hot, thin aviation lacquer sealant 7242 for 30 minutes in finished state and the splice filled accordingly. Further painting is unnecessary.

f) Electrical bridging must be finished up to the bare metal and may only then be painted. Current transfer points must be left bare.

g) Tubing (exterior only) and lettering and national and military markings must be painted with aviation lacquers 7160 (formerly: and 7161 "deleted by Amendment September 1939") in the prescribed colours.

h) Metal air screws will be painted with lacquers 7142.- and 7146.70; the aviation lacquer to be used for wooden air screws will be published in the Luftwaffe Regulation Sheet in due course.

i) Battery mountings will be painted with aviation lacquer 7117.02 (formerly: 7170.42 "Amended by amendment September 1939").

k) Inaccessible areas, angles and corners and those exposed to deterioration may additionally be coated with aviation sealant 7243 when painting is complete.

l) Exhaust pipes will be rubbed down with engine oil and painted with Kernik Black from G. Collardin, Cologne Braunsfeld.

Use of lacquers

Delivery conditions for lacquers

a) to be supplied in containers that permit easy mixing, pouring and proper storage.

b) Markings on containers must be water-proof and resistant to lacquer spills.

c) Delivery to be made in two separate components: "Unthinned" and "thinner". The thinner will be that prescribed for the lacquer. The mixing ratio for each kind of application must be specially indicated.

d) The legend will include:
i) the name and address of the paint manufacturer
ii) the number of the lacquer or thinner as prescribed, e.g. "Aviation lacquer 7107.02"
iii) the range of application and group of the lacquer in brackets, e.g. (unthinned lacquer for metal, Aviation lacquer system 04)
iv) sprayable in .... Parts by volume
dippable in .... Parts by volume,
brushable in .... Parts by volume
mix unthinned lacquer with aviation lacquer thinner No. ... with 1 part by volume and apply as instructed
v) delivery date.
The word "unthinned" will be printed across the legend in red.

e) "d" does not apply to thinners (Nos. 200 - 239) or sealing compounds.

f) lacquers containing dirt particles (sieve!) must be returned.

Lacquer storage and preparation

The temperature in lacquer stores may not be less than +5° C.
Lacquers stored separately must be stirred for 30 minutes after the two components have been mixed in the prescribed ratio with the stirrer from Brea GmbH Jena or equivalent and be ready for application when the ambient temperature is reached. Adequate preparation will be checked by continuous measurement in a viscosity meter with 3 mm opening (from Franz Hering, Jenaer Apparatebauanstalt, Jena) at 18-21° C.

Cleaning of construction materials

a) Metal surfaces will be cleaned with
i) perchlorethylene (Dr Alexander Wacker GmbH, Munich) in permanent installations

ii) P3 Almeco (Henkel und Cie AG, Dusseldorf) in permanent installations

iii) aviation cleaning agent Z (Warnecke & Böhm A.G. Berlin - Weissensee, Goethestr.) for manual application

and must be dried before painting.

b) Wood may be cleaned only on visible soiling (rubbed down with emery paper 000). Highly soiled fabric must be returned to the manufacturer.

c) Painted materials must be treated with the appropriate substances and not with the cleaners indicated above (see Rules for Paint Care).

d) P3 (Henkel und Cie. A.G. Dusseldorf) or strippers may not be used to clean built-in unpainted or painted materials.

Painting generally

a) Lacquer application

Lacquers will in principle be applied in accordance with the instructions for use. Separately stored lacquers are ready for use when processed.

Principle:

Lacquers will be so sprayed or brushed that a flawless coat is achieved. Enamels may be used only with prior RLM approval and will be so applied that temperatures of 100 C and baking periods of five hours are not exceeded for materials of the Duralumin type (aviation materials Nos. 3100 - 3199) or temperatures of 200° C and baking periods of two hours for all other metals.

Scrupulous cleanliness will be observed in the paintshop and when handling lacquered parts. Unless the processing instructions and, especially, the drying periods are closely observed, flawless lacquering cannot be achieved. Haste in lacquering work will only result in delays, as the lacquering will have to be repeated.

b) Appropriate shade.

Exterior

Topcoat colour: 02

Shade 01 is also permissible for trainers after obtaining RLM approval beforehand.

Interiors

Shade as for exterior.

Shade 01 is permissible only after obtaining RLM approval beforehand. Shades will be indicated together with the order for the use of camouflage paints. They are listed in Annex 1 as shades 22, 61, 62, 63, 65, 66, 70 and 71.

The types of paint remain unchanged for aircraft with standard camouflage. However, the last coat in the group will be applied not in the shade prescribed above but in the camouflage shades. Aviation lacquer 7110 is also available in all camouflage shades. The silver groups are normally excluded. Should camouflage also be prescribed for these, information on applying the paint must be obtained from the RLM Engineering Office.

c) Special working conditions

1. Naked flame, smoking and the presence of glow-type heaters ('solar' radiators) are fatal in paintwork shops and are therefore prohibited.
2. Lacquers will be applied by:
   spraying with a spray-gun with 1.8-2.5 mm jets at working pressures of 3-4 atmospheres (normal application).
   brushing
   dipping
   coating and subsequent pouring off (for hollow articles).

Normal application of a coat:

Spraying once only in criss-cross pattern, i.e. The area to be painted is either first pre-sprayed in one direction and at right angles thereto immediately afterwards or, preferably, the entire article first in one direction and then at right angles thereto after initial drying.

3. Paint will be applied in paint shops at temperatures at 18-25° C for air and paint and at a relative air humidity of 50-75%. The climate will be continuously monitored with surf-scribing devices. Strip charts will be retained.

No special paint shop is necessary for minor repairs. An enclosed space suffices. Higher temperatures may be used to speed up paint drying only with prior RLM approval.

4. Paint will be applied in completely dust-free and mist-free environments. Paint mist must be prevented from settling in aircraft parts in all circumstances.

Paint shops must be provided with proper exhaust systems. Local horizontal booth exhausting is adequate for minor work but vertical exhausting to the rear is applied for major work.

Special painting rules

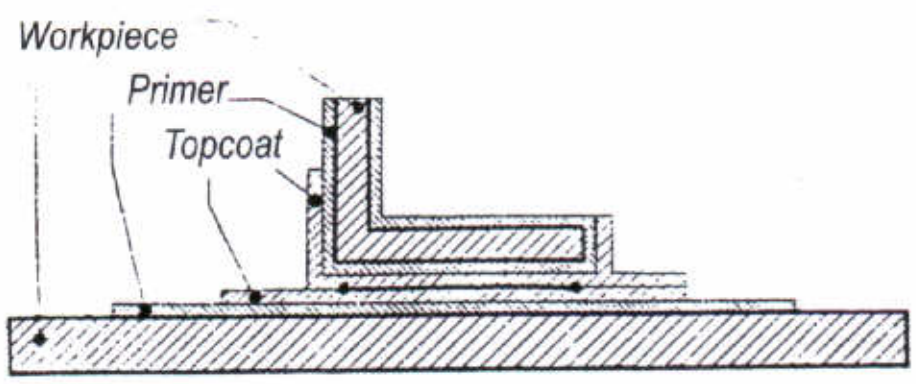
a. Surplus sealant settling on metal on sealing rivet sets must be immediately removed and not left until further preservation.

b. Wet and sharp dry sanding are permitted for special purposes and only with RLM approval.

c. The number of prescribed work processes and the prescribed drying times must be strictly observed.

d. Metal structures, supporting surfaces, fuselages etc. must always be earthed before spraying is commenced.

e. Inaccessible areas must be finally painted before assembly. Successive coats must always be applied with a run-off to areas where the connecting sections are ready painted after assembly to enable any subsequent coat to be applied without problems. For example:



A single coat of the primer from the prescribed lacquer group on each seam surface is sufficient for preserving riveted seams. The primer for a metal system may conveniently be applied as soon as work shop processing commences if careful treatment of prepainted parts is to be guaranteed (Cleaned! Grease-free!).

f. Plastic wood may be used for filling minor damage to wooden parts before the lacquer is applied. The first coat may be applied only after careful drying. The

workshop management's consent must be obtained beforehand when using plastic wood.

g. Stopping may not be used without express RLM consent beforehand.

h. Accidentally soiled metal and wood lacquers (primer) may be cleaned with a very fine steel wall (No. 00). The surface of the metal or wood may not be damaged in consequence and paint removed must be replaced. Residues of steel wool must be removed without trace.

i. Painting errors must be reported to the workshop management immediately on detection for remedying.

k. Appearance of finished paintwork: the surface of the finished lacquering must be as dull as possible (see enclosed sample, Annex 5). Gloss or high gloss may be used for painting aircraft only with special RLM approval.

l. Instructions for applying individual aviation lacquer groups and lacquers for workshop use:

Aviation lacquer group 01 application instructions **

Aviation lacquer	7102.-
Aviation lacquer	7105.02
Aviation lacquer	7106.-
Aviation lacquer thinner	7200.00
Aviation sealing paste	7240.-

Application

1. Degreasing with a substance listed in item 3.
2. Spray aviation lacquer 7102.-* thinned 10:1 with aviation thinner 7200.00. Drying time at least 6 hours.
   Commencement of assembly; filling of seams during riveting with aviation sealing paste 7240.-
   Clean the soiled parts after assembly with very light rubbing down with very fine steel wool and touch up any bare patches with aviation lacquer 7102.- thinned 10:1 with aviation thinner 7200.00 allowing at least 6 hours' drying time.
   Fill external seams with aviation sealing paste 7240.
3. a) spraying of internal parts with aviation lacquer 7105.02
   b) spraying external parts with aviation lacquer 7106.-
   both thinned 4:3 with aviation thinner 7200.00.
   Drying time at least 3 hours.
4. Spraying of external parts with aviation lacquer 7107.02 thinned 2:1 with aviation thinner 7200.00 allowing 3 hours drying time.

* Spraying refers to cross-wise spraying in each case.

** Lacquer group No. 01 may continue to be used only until the individual lacquers have been used up. It will then be replaced with lacquer group 04.

Aviation lacquer group 02 application instructions

Aviation lacquer	7102.-
Aviation lacquer	7106.-
Aviation lacquer	7108.02
Aviation lacquer	7107.02
Aviation lacquer thinner	7200.00

I. Application to the interior of floats and the interiors and exteriors of hulls.

1. Degrease with one of the agents listed under 4.9.1.2.
2. Spray aviation lacquer 7102.- thinned 10:1 with aviation thinner 7200.00.
   Fill external seams with aviation sealing past 7240.
3. Spray aviation lacquer 7106.- thinned 2:1 with aviation thinner 7200.00.
   Drying time 3 hours.
4. a) spray aviation lacquer 7108.04 on underwater parts thinned 2:1 with aviation thinner 7200.00
   Drying time 4 hours.
   b) spray aviation lacquer 7107.04 on above water parts thinned 2:1 with aviation thinner 7200.00.
   Drying time 4 hours.

II. Application to float exteriors

1. as above
2. as above
3. aviation lacquer 7106.27 (and also as above)
4. aviation lacquer 7108.04 on above water and under water parts.
   Drying time as I.

Aviation lacquer group 03 application instructions

Aviation cleaning agent	Z
Aviation lacquer	7102.-
Aviation lacquer	7105.01
Aviation lacquer	7106.-
Aviation lacquer	7107.01
Aviation lacquer thinner	7200.00
Aviation sealing paste	7240.-

Application

1. Degrease with aviation cleaning agent Z.
2. Spray aviation lacquer 7102.-* thinned 10:1 with aviation thinner 7200.00. Drying time at least 6 hours.
   Commencement of assembly; fill seams during riveting with aviation sealing paste 7240.-
   Clean the soiled parts after assembly with very light rubbing down with very fine steel wool and touch up any damaged parts and bare rivets with aviation lacquer 7102.- thinned 10:1 with aviation thinner 7200.00 allowing at least 6 hour's drying time.
   Fill external seams with aviation sealing past 7240.
3. a) spray the interiors with aviation lacquer 7105.01
   b) spray external parts with aviation lacquer 7106.-

both thinned with aviation thinner 7200.00.
Drying time at least 3 hours.

4) Spray exterior parts with aviation lacquer 7107.01 thinned 2:1 with aviation thinner 7200.00 allowing 3 hours drying time.

* Spraying refers to cross-wise spraying in each case.

Aviation lacquer group 04 application instructions

Aviation lacquer	7102.-
Aviation lacquer	7109.02
Aviation lacquer thinner	7200.00
Aviation sealing paste	7240.-

Application

1. Degrease.
2. Spray aviation lacquer 7102.- thinned 10:1 with aviation thinner 7200.00.
   Drying time at least 6 hours.
3. Spray aviation lacquer 7109.02 thinned 2:1 with aviation thinner 7200.00
   Drying time 6 hours.
   Also in shades 22, 61, 62, 63, 65, 66, 70 and 71 as camouflage.

Aviation lacquer group 05 application instructions

Aviation lacquer	7113.-
Aviation lacquer	7114.01
Aviation lacquer	7115.02
Aviation lacquer thinner	7213.00

Application

1. Degrease.
2. Spray aviation lacquer 7113.-
   Drying time 2-3 hours.
3. Spray aviation lacquer 7114.01
   Drying time 2 hours.
4. Aviation thinner 7213.00 1 part by volume
   Aviation lacquer 7115.02 2 parts by volume

Aviation lacquer group 20 application instructions

Aviation lacquer	7130.- (also to be used as adhesive lacquer)
Aviation lacquer	7135.02
Aviation lacquer	7136.00
Aviation lacquer thinner	7230.00

Application: dry, clean fabric

1. 1 x aviation lacquer 7130.- Paint after 2 hours
2. 1 x aviation lacquer 7130.- Paint after 2 hours
3. 1 x aviation lacquer 7130.- Paint after 2 hours
4. Grind lightly (dry)
5. 1 x with a mixture comprising:
   Criss-cross spray
   9 parts by volume of lacquer 7135.02
   1 part by volume aviation thinner 7230.00
   After 4 hours
6. 1 x with mixture comprising:
   Criss-cross spray
   9 parts by volume lacquer 7135.02
   1 part by volume aviation thinner 7230.00
   After 4 hours
7. Even up with aviation thinner 7230.00
   After 2 hours
8. 1 x with a mixture comprising:
   Criss-cross spray
   5 parts by volume lacquer 7135.02*
   2 parts by volume lacquer 7136.00
   3 parts by volume aviation thinner 7230.00
   Drying time 6 hours
   Preferably over-night

* Also in camouflage shades 61, 62, 63, 65, 70 & 71

Aviation lacquer group 21 application instructions

Aviation lacquer	7130.-
Aviation lacquer	7135.01
Aviation lacquer thinner	7230.00

Application: on clean, dry fabric

1. 1 x aviation lacquer 7130.- Paint after 2 hours
2. 1 x aviation lacquer 7130.- Paint after 2 hours
3. 1 x aviation lacquer 7130.- Paint after 2 hours
4. Grind lightly (dry)
5. 1 x with a mixture comprising:
   Criss-cross spray
   9 parts by weight of aviation lacquer 7135.01
   1 part by weight aviation thinner 7230.00
   After 4 hours
6. Even up with aviation thinner 7230.00
   After 2 hours
7. 1 x with a mixture comprising:
   Criss-cross spray
   9 parts by weight aviation lacquer 7135.01
   1 part by weight aviation thinner 7230.00
   Drying time 6 hours
   Preferably overnight

Aviation lacquer group 22 application instructions

Aviation lacquer	7137.-
Aviation lacquer	7115.02
Aviation dispersion	7215.00
Aviation thinner	7213.00

Application: on clean, dry fabric

1. 85 parts by weight aviation lacquer 7137.-
   15 parts by weight aviation thinner 7213.00
   Paint after 2 hours
2. 1 x aviation lacquer 7137.- Paint after 2 hours
3. 1 x aviation lacquer 7137.- Paint after 2 hours
4. Aviation thinner 7215.00 After 1 - 2 hours
5. 2 parts by weight aviation lacquer 7115.02
   1 part by weight aviation thinner 7213.00

Spray after 2-3 hours

6. Spray aviation lacquer 7115.02 2 parts by weight
   Aviation thinner 7213.00 1 part by weight
   Drying time preferably overnight

Aviation lacquer group 30 application instructions

Aviation lacquer	7131.00
Aviation lacquer	7132.-
Aviation lacquer	7135.02
Aviation lacquer	7136.00
Aviation thinner	7230.00

Application: on a clean, dry wood surface

1. 1 x aviation lacquer 7130.00 Saturation paint
   after 3 hours
2. 1 x with a mixture comprising:
   Spray criss-cross
   4 parts by weight aviation lacquer 7132.-
   1 part by weight aviation thinner 7230.00
   After 5 hours
3. Even up with aviation thinner 7230.00
   After 2 hours
4. 1 x with a mixture comprising:
   Criss-cross spray
   9 parts by weight aviation lacquer 7135.02
   1 part by weight aviation thinner 7230.00
   After 4 hours
5. 1 x as step 4
   Spray criss-cross after 4 hours
6. Even up with aviation thinner 7230.00
   After 2 hours
7. 1 x with a mixture comprising:
   Spray criss-cross
   5 parts by weight aviation lacquer 7135.02*
   2 parts by weight aviation lacquer 7136.00
   3 parts by weight aviation thinner 7230.00
   Drying time 6 hours
   Preferably overnight

* Also in camouflage shades 61, 62, 63, 65, 70 & 71.

Author's note:
Aviation lacquer 7130.00 is prescribed for step 1. However, this lacquer does not belong to this group. This may be a printing error, since 7131.00 would be correct. Camouflage shades 22 and 66 included under the other groups are also missing.

Aviation lacquer group 31 application instructions

Aviation lacquer	7131.00
Aviation lacquer	7132.-
Aviation lacquer	7135.01
Aviation thinner	7230.00

Application: on a clean, dry wooden surface

1. 1 x aviation lacquer 7131.00 Saturation paint
   after 3 hours
2. 1 x with a mixture comprising:
   Spray criss-cross
   4 parts by weight aviation lacquer 7132.-
   1 part by weight aviation thinner 7230.00
   After 5 hours
3. Even up with aviation thinner 7230.00
   After 2 hours
4. 1 x with a mixture comprising:
   Criss-cross spray
   9 parts by weight aviation lacquer 7135.01
   1 part by weight aviation thinner 7230.00
   After 4 hours
5. Even up with aviation thinner 7230.00
   After 2 hours
6. 1 x with a mixture comprising:
   Spray criss-cross
   9 parts by weight aviation lacquer 7135.01
   3 parts by weight aviation thinner 7230.00
   Drying time 6 hours
   Preferably overnight

Aviation lacquer group 32 application instructions

a) Interiors:
   Aviation lacquer 7180.22
b) Exteriors:
   Aviation protective oil 7184.-
   Aviation lacquer 7145.04
   Aviation lacquer 7162.01 and 7162.04

Application:

a) Interiors:
   Coat float completely with aviation protective oil 7180.22
b) Exteriors:
   1 x spray throughout with aviation protective oil 7161
   Drying time 6 hours

Then above water

1 x aviation lacquer 7145.04 spray criss-cross
Drying time 6 hours
1 x aviation lacquer 7145.04 spray criss-cross
Drying time 6 hours

Under water

1 x aviation lacquer 7162.01 spray criss-cross
Drying time 6 hours
1 x aviation lacquer 7162.04 spray criss-cross
Drying time 6 hours
1 x aviation lacquer 7162.04 spray criss-cross
Drying time 6 hours

Aviation lacquer group 33 application instructions

Aviation lacquer	7138.-
Aviation lacquer	7139.01
Aviation lacquer	7115.02
Aviation dispersion	7215.00
Aviation thinner	7213.00

Application: on a clean, dry wooden surface

1. 1 part by weight aviation lacquer 7138.-
   1 part by weight aviation thinner 7213.00
   Rub in, after 3 hours
2. 9 parts by weight aviation lacquer 7139.01
   1 part by weight aviation thinner 7213.00
   Spray, after 2 hours
3. Even up with aviation dispersion 7215.00
4. 2 parts by weight aviation lacquer 7115.02
   1 part by weight aviation thinner 7213.00
   Spray, after 2 4 hours
5. 2 parts by weight aviation lacquer 7115.02
   1 part by weight aviation thinner 7213.00
   Spray,

Application instructions for aviation lacquer 7140

Aviation lacquer	7140.-
Aviation thinner	7233

Application:

1. 3 parts by weight aviation lacquer 7140.- and
   Spray criss-cross
   1 part by weight aviation thinner 7233
   After 3 hours
2. 3 parts by weight aviation lacquer 7140.- and
   1 part by weight aviation thinner 7233
   After 3 hours
3. 3 parts by weight aviation lacquer 7140.- and
   1 part by weight aviation thinner 7233
   Spray criss-cross

Aviation lacquer 7117 application instructions

Aviation lacquer	7117.02
Aviation thinner	7200.00

Application:
On the finished paint system or on aviation lacquer 7102.- or 7110.02
1 x aviation lacquer 7117.02 sprayed criss-cross, thin 3:5 with aviation thinner 7200.00.
Drying time 3 hours.

Application instructions for aviation lacquer 7160

Aviation lacquer	7160.21 - 7160.23 and 28
Aviation lacquer	7161.23 - 7161.27
Aviation thinner	7232.00
Aviation thinner	7233.00

Application:

a) National markings and lettering
   On the existing paintwork
   1 x aviation lacquer 7160.21 - 7160.23 and 28
   Spray*
   Thinned 1:1 with aviation thinner 7232.00
   Drying time 1 hour
   1 x aviation lacquer 7160.21 - 7160.23 and 28
   Spray
   Thinned 1:1 with aviation thinner 7232.00
   Drying time 1 hour

b) Markings for tubing etc.
   On bare metal
   1 x aviation lacquer 7161.21 - 7160.27
   Spray

or

   Dip, thinned 2:1 with aviation thinner 7234.00

or

   Brush, thinned 3:1
   Drying time 1 hour

* Aviation lacquers 7160.21 - 7160.23 and 28 when used should be thinned: 3:1

Shades 22, 23, 24, 25, 26 and 27 correspond to the DIN L 5 colours.
Aviation lacquers 7161.23 - 27 were deleted by Amendment September 1939.
NB: Existing stocks of aviation lacquer 7163.23-27 and aviation thinner 7234.00 must be used up (supplemented by amendment September 1939).

Application instructions for aviation lacquer 7136.00

Aviation lacquer	7136

Application:
On the finished paintwork
1 x aviation lacquer 7136
Spray
Drying time 2 hours

Application instruction aviation lacquer 7142.- and 7146.70

Metal air screw lacquering

Aviation lacquer	7142
Aviation lacquer	7146.70
Aviation thinner	7200.00
Aviation cleaning agent	Z

Application:

1. The backs of the propellers are carefully degreased with aviation cleaning agent Z and cleaned
   On this,
2. 1 x aviation lacquer 7142 is sprayed thinly (thinned 4:5 with aviation thinner 7200.00)
3. After a drying time of 1 hour
   Spray 2 x aviation lacquer 7146.32
   (thinned 1:1 with aviation thinner 7200.00) in criss-cross pattern

The application instruction for painting wooden air screws will be published shortly in the Luftwaffe Regulation Sheet.

Author's note: Working step 3 refers to aviation lacquer 7146.32. This is undoubtedly a printing error since this shade (32?) is unknown and the application instruction indicates aviation lacquer 7146.70.

Application instruction for aviation lacquer 7110

Aviation lacquer	7110.02
Aviation thinner	7200.00

Application:

1. Degrease with one of the agents indicated in 4.9.1.2, Section 3.
2. a) Interiors
   Aviation lacquer 7110.02 or 01
   Thinned 5:1 with aviation thinner 7200.00 sprayed or brushed.
   Drying time 6 hours.

   b) Exteriors
   Aviation lacquer 7110.02*
   Thinned 5:1 with aviation thinner 7200.00 sprayed or painted.
   Drying time at least 6 hours.

* Aviation lacquer 7110.02 is also supplied in shades 01, 22, 61, 62, 63, 65, 66, 70 and 71. The thinning ratio depends on the shade applied:

01	thinned	10:1
22	"	3:1
61	"	4:1
62	"	10:1
63	"	10:1
65	"	10:1
66	"	4:1
70	"	5:1
71	"	5:1

Application instructions for aviation lacquer 7111.00 transparent yellow

Aviation lacquer	7111.00 transparent yellow
Aviation thinner	7200.00

Application:

1. Degrease rivet heads and bare metal parts assembled from anodised components.
2. Spray the parts mentioned in Step 1 with aviation lacquer 7111.00 transparent yellow thinned 1:1 with aviation thinner 7200.00 or brush on unthinned.
   Drying time 3-4 hours.

Application instructions for aviation lacquer 7118.00 transparent blue

Aviation lacquer	7118.00 transparent blue

Application:

1. Anodised and post-sealed parts are dipped immediately and after drying
2. 1 x in unthinned aviation lacquer 7118.00 (transparent blue) or sprayed with the same lacquer.
   Drying time 1 hour.

Application instruction for aviation binder 7245, aviation binder 7246, aviation seal 7243 and aviation sealing paste 7242

Aviation binders 7245 and 7246 serve as an undercoat between seam rivets at points where these must be water and air-tight. They can also be used as sealant at other points on the aircraft, especially where an increased corrosion risk may be expected through contact between different metals (e.g. steel and light metal).

Aviation binder 7245 or 7246 is applied before riveting to the parts to be sealed which must have been thoroughly cleaned beforehand as directed, in such a way that they do not project from the seam. They are best applied laid back approx. 2 mm against the edge.

Aviation seal 7242 (painted on) or 7243 (applied with putty knife) is used as an after-seal for riveted areas.

Application instruction for aviation binder 7255*, aviation binder 7256* and aviation sealing paste 7253*

Aviation binders 7255 and 7256 are used as an intermediate layer between riveted seams at points where attack by fuel and water may be expected. Aviation sealing paste 7253 is applied with a putty knife on both sides of the metal surfaces to be riveted after cleaning as directed. The aviation binder is then applied, the parts being joined to each other with set screws and subsequently riveted. Riveting should follow within 8 hours.

* The above instruction will be replaced by the following when existing stocks have been used up.

Processing instruction for aviation binder 7260, aviation sealing paste 7261 and aviation sealing paste 7262

Aviation binder 7260 is used as an intermediate layer between riveted seams at points where attack by fuel and water may be expected. Aviation binder 7260 is coated strongly but evenly with aviation sealing paste 7261.- to both sides either by hand or by a machine produced by the supplier. Aviation binder 7260 treated in this way is applied tight and uncreased to the metal strips to be riveted. The metal strips are then joined with set screws or the like with subsequent riveting, which must follow within 8 days. If necessary, even

out any hollow areas with aviation jointing paste 7262.-.

Treatment of fresh aviation paintwork

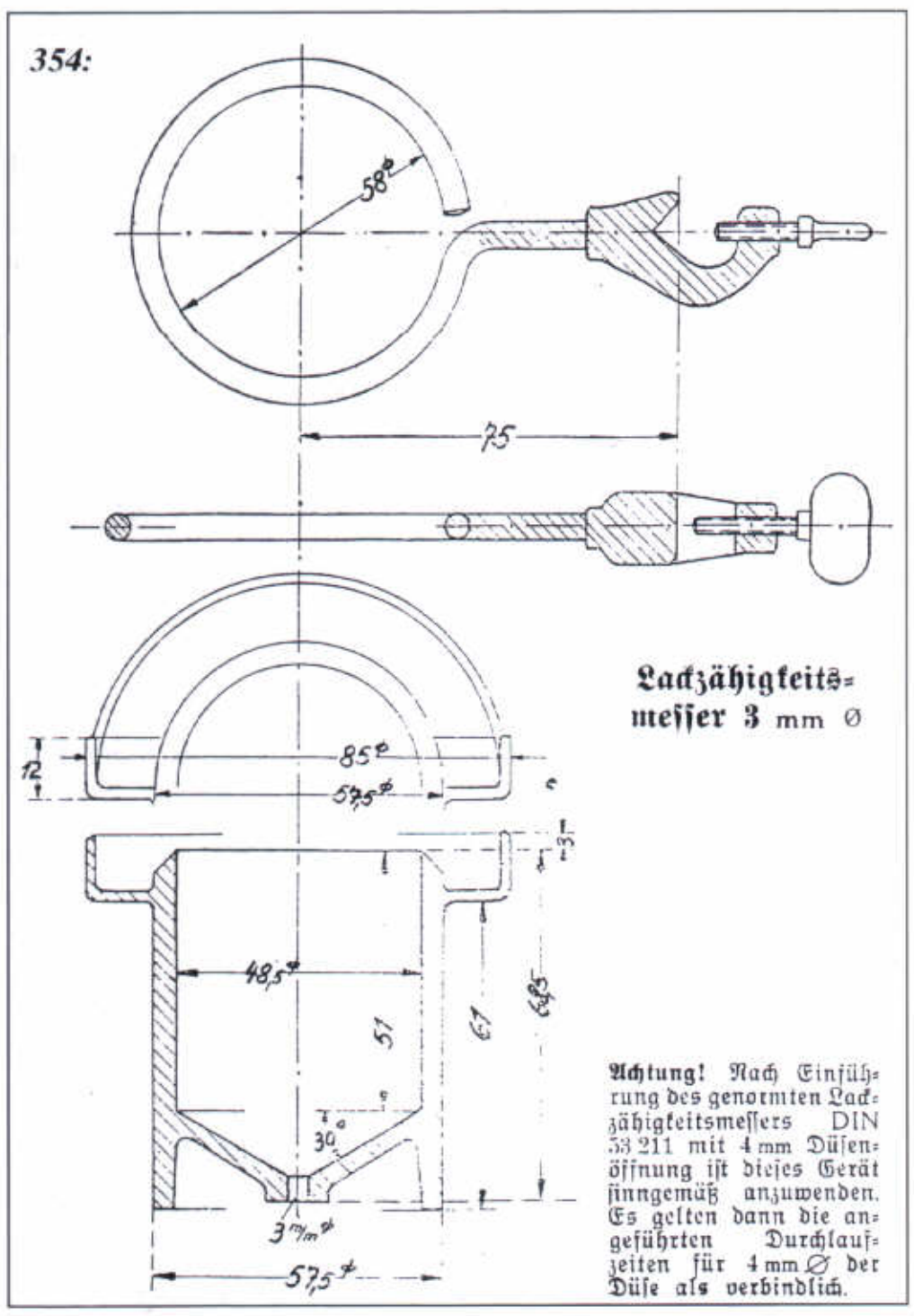
1. Paint may be fully exposed to the weather not less than 48 hours after the last coat has been applied. Flying boats and seaplanes may not be launched until 72 hours following completion of painting and left permanently in the water only 14 days following completion. Time in the water is limited to 8 hours per day from the third to the fourteenth days.

2. A protective agent to be indicated separately by the RLM will be applied to the newly painted aircraft before delivery to the operator and not later than one month after the topcoat has been applied. The protective coat should be applied only after the paint has dried thoroughly and, if possible, at least two weeks after painting. The protection may not be applied too thick and must be rubbed down with a dry rag to ensure a matt finish and prevent dust from settling. The paint must in all circumstances be thoroughly dry before the protective coat is applied.

Viscosity gauge 3 mm

Instructions for use:

The appliance is fastened to a stand or in any other suitable position using the mountings supplied. Care should be taken before measurements are made that the outlet car in particular, is entirely clean.



When taking measurements, the outlet is first closed with a finger of the left hand. The paint to be measured is poured into the weaker until it flows over the edge. When it has stopped flowing over the edge, the outlet is opened by removing the finger and a stop-watch is started at the same time. The procedure ends when the outward flow ceases. The number of seconds required for the paint to flow out indicates the viscosity.

The accuracy of the measurement depends on the temperature, which must be between 18° and 21° C.

RLM Instruction for cleaning metal parts in permanent installations using perchloro-ethylene (PER)

1) Installations:

Degreasing installations from A. Bader, Munich, are used for cleaning. The size of the installation depends on the amount of material to be passed through in each case. The installations consist of:

a) A washing bath. Three washbasins in which the parts to be decreased are suspended using wire baskets are arranged next to each other in a large external frame. A cooling installation provided with running mains water runs along the top part of the frame internally and serves to precipitate the evaporating PER.

Each basin contains 30 litres of PER, which is heated to +90° C through built-in steam hoses.

b) Distillation plant. This is used for cleaning or recovering perchloroethylene containing grease.

2) Operating method:

Per is a very sharp solvent for grease, oils, resins and lacquers and removes the substances from metal parts without trace after an application period of appropriate length. Per is non-flammable!

3) Working procedure:

i. Place the parts to be degreased in the wire baskets.

ii. Suspend the first basket in the first washbasin, and then in the second and finally in the third. Exposure in the first basin 5 minutes, in the second and third a brief dip. Ongoing process.

iii. Dip the basket from the third basin to just beneath the top edge of the frame. The metal parts are dried immediately by their specific heat.

iv. Removal of the wire baskets and passing on of parts for painting or anodizing.

v. The perchloroethylene must be pumped out of the washbasins into the distillation plant daily (see 1b) and the per distilled off to remove impurities.

Second Edition of Treatment and Application Instructions for Aviation Lacquers (1938 Edition)

The contents of the copy in the author's possession are entirely identical with the L.Dv 521/1 1938 Edition as described in the previous chapter, subject to two differences as follows:

Amendments have been inserted in Chapter 6 (basic edition of L.Dv 521/1 of 1938) while the second edition shows the original position.

The second difference is the following note on the title page of the second edition:

"The present Treatment and Application Instructions for aviation lacquers must now be used in your area of work. Shades 70 and 71 listed on the colour chart may on no account be produced or transferred abroad under this designation."

The differences from the basic edition of L.Dv 521/1 of 1938 are as follows in detail:

In Chapter B (listing of various lacquer groups, single lacquers and sealants), sub-section 3 (single lacquers), the following appears:

"**Aviation lacquer 7170.-**

For painting battery mountings and wooden and metal parts exposed to acids

Aviation lacquer 7170.-
Avionorm Nitro topcoat light grey 1791
Lüdicke & Co., Berlin - Wilmersdorf, Kaiserallee 31

This includes: aviation thinner 7131.00 Avionorm acid thinner."

The later paragraph referring to aviation lacquer 7118.00 does not appear in the second edition.

Author's note: This amendment also removes the only reference in an official document of which I am aware to shade 42.

The following difference from the 1938 basic edition appears in Chapter D (Use of Lacquers):

"**Processing instruction for aviation lacquer 7170.-**

Aviation lacquer	7170
Aviation thinner	7231.00

Application:
1) On the finished paint system
1 x aviation lacquer 7170 sprayed criss-cross
Drying time 3 hours."

355 Below: *The matt finish to the 74/75/76 camouflage on this Bf 109F-4 reconnaissance aircraft of 1.(F)/122, F6+WL, is as it should be according to the regulations. The pattern is as the OS List except that the underside 76 has been brought up over the wing leading edge. Note the RLM Grau 02 of the undercarriage leg and the 66 to the cockpit interior and head armour*

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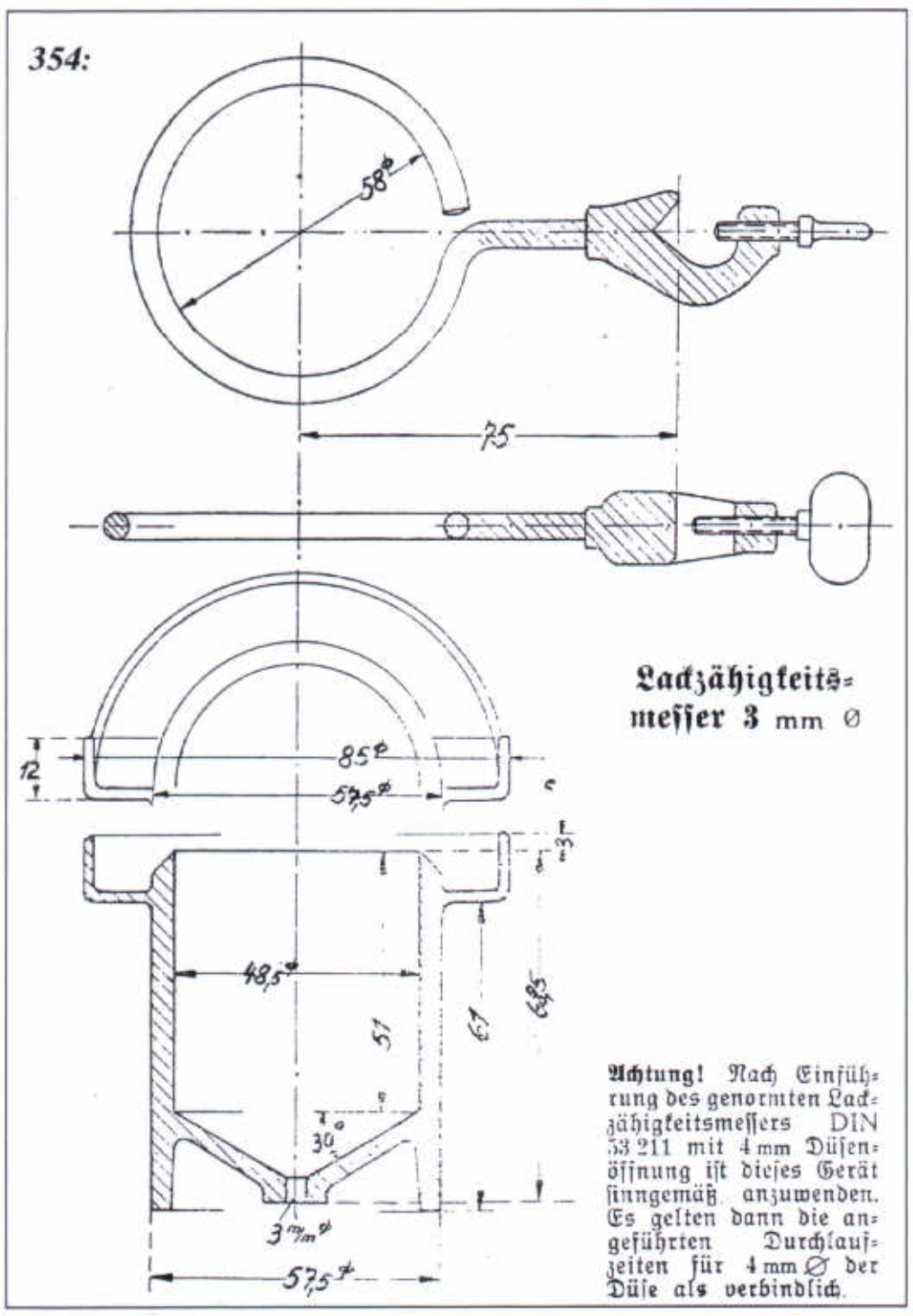

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LDv 521/1

Handling and Application Instructions for Aircraft Paints 1941

Part 1: Powered Aircraft

November 1941

The Reich Minister of Aviation
and Commander-in-Chief of the Luftwaffe
Engineering Office No. 26920/41 (GL/C-E2 VII C)
I hereby approve this edition of L.Dv 521/1

Berlin, 8 November 1941

"Handling and Application Instructions for Aviation Lacquers"
Part 1: Powered Aircraft, November 1941
Takes effect on the date of publication.
Earlier editions of L.Dv 521/1 "Draft Treatment and Applications-Instructions for Aviation Lacquers"
and
TAGL I P 10g No. 8/40 Serial No. 49/40 of 24.12.40 and
TAGL I P 10g No. 18/41 serial No. 363/41 of 24.6.41
are withdrawn as from the same date.

pp.
Vorwald

Introduction

This new edition of the L.Dv 521/1 for 1941 has been revised in the national interest. For particular reasons, the multi-coat painting of aluminium alloys has been dispensed with, except for naval aircraft and those used in the tropics. Exceptions include electron, steel and non-flammable metal alloys for carrier-borne aircraft only.

The standard lacquer for interior and exterior painting is aviation lacquer 7122 in its various shades.

The shades 61, 62 and 63 are no longer used. These colours have been replaced by standard camouflage shades 70 and 71 for all land combat aircraft, 72 and 73 for all naval combat aircraft and 74, 75 and 76 for fighters and destroyers.

The standard colour for naval aircraft in shade 04 has been withdrawn.

Trainers and practice aircraft will now be painted only in the standard camouflage shades applicable. Silver paint (shade 01) may not be used for either interiors or exteriors.

Cockpit areas of all aircraft will in principle be painted in shade 66.

For the duration of the war, protective coatings will not be applied to aircraft (exceptions apply only with RLM approval, see Chapter 2). Aviation cleaning agent 7238 will be used as cleaning agent for painted aircraft.

Night camouflage lacquers 7120.22 and 7124.22 (temporary and permanent) are new and for the time being may be applied only in the field as instructed.

Lacquers for painting metal and those for wood and fabric have been generally available to the Luftwaffe since 1939. They are produced by a number of leading paint manufacturers under licence using an original supplier's recipes (see Chapter 2).

General

Purpose of painting

a) Purpose protection: protection of the aircraft material against the disruptive effects of the weather, water and adhering substances. Increasing the working life of the aircraft.
b) Achieving an air-worthy condition of materials (fabric).
c) Enhancing aircraft recognition.

Definitions

a) Lacquer = a liquid which after application to a surface produces a resistant coat when dry.
b) Lacquering = the viable coating obtained from the processed lacquer.
c) Lacquer group = particular sequence of lacquers which when applied one after the other according to the processing instructions for the group produces a

finished lacquering.
d) German raw materials = German raw materials are those that can be obtained in sufficient quantities in Germany. Raw materials which may exist in large quantities but cannot be obtained in Germany are not regarded as German raw materials.
e) Useful life = useful life means the time after which lacquering which has been maintained according to the regulations requires renovation following uninterrupted exposure to the effects of the weather. The figure is reduced by one half for time spent in the hanger.

Overview of surface protection agents

Group A Corrosion-proof material (e.g. stainless steel)
Group B Corrosion-inhibiting metal skin of the material (applied by plating, galvanising or a metal spray process) and additional pro tective paints.
Group C Non-metallic protective coatings (chemi cally produced, e.g. anodising, atramentation and phosphetizing processes) and ad ditional protective paints.
Group D Lacquers (air-drying, stove-drying) applied to otherwise unprotected materials.

Listing of the various lacquer groups, single paints

General

The lacquers forming a lacquer group are listed below either in individual groups, together with an overview. When applied, the following rules generally and the processing regulations for the lacquer concerned must be closely followed. Lacquers and lacquer groups other than those prescribed may be used only on specific prototypes (aircraft using experimental paints, and the like) with the express prior permission of the RLM Engineering Office. The surface protection lists (OS Lists) accompanying the log book for each aircraft will be simplified with the entry to effect of these Rules.

Digit designations of lacquers and lacquer groups:

a) The lacquer groups are identified with a two-digit number. Groups for metal surfaces are numbered 01 to 19. Groups for fabric and wooden surfaces are numbered 20 to 30.
b) Lacquers are identified by four digits. Lacquer shades are designated by two digit numbers, following and separated from the four digit lacquer number by a point. For example:

Aviation lacquer	7107	02
	Lacquer designation	Shade designation

Designates: Metal lacquer RLM - Grau

Lacquer groups for aircraft operators and overhaul depots, and their application rules

Lacquer Group 01 (coloured)

No longer applicable.

Author's Note: See L.Dv 521/1 of 1938 for further particulars

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Lacquer group 02 (coloured)

This lacquer group may be used only for painting metal floats, flying boat hulls and tropical aircraft.

The procedures under (a) and (B) are adopted since the aluminium alloys in naval aircraft must in principle be anodised by RLM special instruction but not all aircraft manufacturers are as yet suited for anodising.

Anodised aircraft:

Aviation lacquer	7118.-
Aviation lacquer	7102.-
Aviation lacquer	7109.02 or standard camouflage shades

Non-anodised and tropical aircraft

Aviation lacquer	7102.-
Aviation lacquer	7106.-
Aviation lacquer	7109.02 or standard camouflage shades

Note: A hyphen after the point following a four-digit lacquer number instead of the two-digit shade means that the precise nature of the shade is unimportant.

Application instructions:

1. Degrease as indicated in Annex 5.
2. Spray 7102.- once only criss-cross thinned with aviation thinner 7200.00 in a ratio of 10:1. Drying time at least 6 hours.
3. Spray aviation lacquer 7106.- thinned with aviation thinner 7200.00 in a ratio of 2:1 once only saturated in criss-cross pattern. Drying time 6 hours.
4. Spray aviation lacquer 7109.65 or 70, 71 etc. thinned with aviation thinner 7200.00 in a ratio of 2:1 once only saturated in criss-cross pattern. Drying time 3 hours.

Aviation lacquer 03 (silver)

No longer applicable

Author's note: See L.Dv 521/1 of 1938 for further particulars.

Lacquer Group 04 (coloured)

This lacquer group is used for exterior painting of aircraft for which single coat painting is not prescribed. It serves as a two-coat system generally in addition to standard lacquer 7122.

Aviation lacquer	7102.-
Aviation lacquer	7109.02 or standard camouflage shades
Aviation lacquer thinner	7200.00

Application instructions

1. Degrease as per Annex 5.
2. Spray aviation lacquer 7102.-, thinned 10:1 with aviation thinner 7200.00.
   Drying time at least 6 hours.
3. Spray aviation lacquer 7109.02.- thinned with aviation thinner 7200.00 in a ratio of 2:1 once only saturated in criss-cross pattern.
   Drying time 6 hours.
   In standard camouflage shades where applicable

Lacquer Group 05 (coloured) non-flammable

This lacquer group may be used only on aircraft originally painted with the lacquers included in it (e.g. carrier-borne aircraft), heavy-duty gliders etc. Aircraft painted with this group may not be touched up with the lacquer groups indicated above, or vice versa.

Aviation lacquer	7113.-
Aviation lacquer	7114.-
Aviation lacquer	7115.02 or standard camouflage shades
Aviation thinner	7213.00

Application instructions

1. Degrease as per Annex 5
2. Spray aviation lacquer 7113.- once only, unthinned. Drying time 2 hours.
3. Spray aviation lacquer 7114.- once only, unthinned. Drying time 2 hours.
4. Spray aviation lacquer 7115.02 thinned with aviation thinner 7213.00 in a ratio of 1:1.
   Drying time 4 hours.
   Once only saturated in criss-cross pattern.
   In standard camouflage shades if applicable.

Lacquer group 20 (coloured)

This group is used only for doping aircraft fabric.

Aviation lacquer	7130.- (it may also be used as adhesive)
Aviation lacquer	7135.02
Aviation lacquer	7136.00
Aviation thinner	7230.00

Application instructions

1. The dry, clean fabric must be pre-tensioned
2. Spray aviation lacquer 7130.- once only, unthinned. Drying time 2 hours.
3. Stick down seam strips with 7130.- as adhesive lacquer now or after the next work step
4. Apply aviation lacquer 7130.- 2-3 times again as under 2 at intervals of 2 hours.
5. Lightly sand dry.
6. Spray aviation lacquer 7135.02 thinned with aviation thinner 7230.00 in a ratio of 9:1, once only saturated in criss-cross pattern.
   In standard camouflage shades if applicable.
7. Repeat 6.
8. Even out (disperse) with aviation thinner 7230.00, drying time 2 hours.
9. The last work step depends on the chosen shade.

   If shade 02: spray once only criss-cross with a mixture of
   5 parts aviation lacquer 7135.02
   2 parts aviation lacquer 7136.00
   3 parts aviation thinner 7230.00
   Drying time 6 hours.

   If standard camouflage shades:
   To ensure a matt finish the mixture excluding lacquer 7136.00 comprises:
   8 parts aviation lacquer 7135 in standard camouflage shade
   2 parts aviation thinner 7230.00.

NB: Aviation stripper 7236.00 may be used instead of thinner 7230.00 in the usual way for partial removal of painting errors.

Lacquer group 22 (coloured) non-flammable

This lacquer group may be used only for doping fabric on aircraft originally treated with the same lacquers (e.g. carrier-borne aircraft, heavy duty gliders, etc.). It may not be touched up with lacquers in the group or vice versa.

Aviation lacquer	7137.-
Aviation lacquer	7115.02
Aviation thinner	7213.00
Aviation dispersion	7215.00 or in standard camouflage shades

Author's Note: The dispersion is undoubtedly wrongly indicated. The standard camouflage shades belong to lacquer 7115.02, see item 6 of the Application instructions.

Application instructions

1. The dry, clean fabric must be pre-stressed appropriately.
2. Apply aviation lacquer 7137.- thinned with

aviation thinner 7213.00 in a ratio of 7:3.
Drying time 2 hours.

3. Stick seam strip down with 7137.- as adhesive lacquer now or after the next work step.
4. Brush on aviation lacquer 7137.- 2 or 3 times again at intervals of 2 hours.
5. Even out (disperse) with aviation dispersion 7215.00, drying time 2 hours.
6. Spray aviation lacquer 7115.02 with aviation thinner 7213.00 thinned in a ratio of 1:1 twice saturated in criss-cross pattern.
   In standard camouflage shades if applicable.
   Drying time 3 hours.

Lacquer Group 30 (coloured)

This lacquer group may be used only on wooden aircraft exteriors. It may not be used for painting wooden floats, hulls, etc.

Aviation lacquer	7131.00
Aviation lacquer	7132.-
Aviation lacquer	7135.02 or in standard camouflage shades
Aviation lacquer	7136.00
Aviation thinner	7230.00

Application instructions

1. Remove dust from the dry wood surface.
2. Brush on aviation lacquer 7131.00 once only saturated.
   Drying time 3 hours.
3. Spray aviation lacquer 7132.- thinned with aviation thinner 7230.00 in a ratio of 4:1, once only saturated in criss-cross pattern, drying time 5 hours.
4. Even out (disperse) with aviation thinner 7230.
   Drying time 2 hours.
5. Spray aviation lacquer 7135.02 thinned with aviation thinner 7230.00 in a ratio of 9:1, twice saturated in criss-cross pattern,
   in standard camouflage shades if applicable.
   Drying time 4 hours.
6. Even out (disperse) with aviation thinner 7230.
   Drying time 2 hours.
7. The last work step depends on the chosen shade:
   If shade 02:
   5 parts aviation lacquer 7135.02
   2 parts aviation lacquer 7136.00
   3 parts aviation thinner 7230.00
   Drying time 6 hours.

   If standard camouflage shades:
   to ensure a matt finish with a mixture excluding aviation lacquer 7136.00 comprises:
   8 parts aviation lacquer 7135 in standard camouflage shade
   2 parts aviation thinner 7230.00.

NB: Aviation stripper 7236.00 may be used instead of thinner 7230.00 in the usual way for partial removal of painting errors.

Author's note: As is evident from work step 7, the admixture of glossy neutral lacquer 7136.00 (shade 00 = neutral) reduces the matt finish of the paint. This is especially relevant when painting models which are lacquered externally overall in 02.

Lacquer group 33 (coloured) non-flammable

This lacquer group may be used only for painting the wooden exterior parts of aircraft originally treated with the same lacquers (e.g. carrier-borne aircraft, heavy duty gliders, etc.). It may not be touched up with paints in Group 30 or vice versa.

Aviation lacquer	7138.-
Aviation lacquer	7139.-
Aviation lacquer	7115.02 or in standard camouflage shades
Aviation thinner	7213.00
Aviation dispersion	7215.00

Application instructions

1. Remove dust from the dry wooden surface.
2. Rub in aviation lacquer 7138.- thinned 1:1 with aviation thinner 7213.00
   Drying time 3 hours.
3. Spray aviation lacquer 7139.- thinned with aviation thinner 7213.00 in a ratio of 2:1
   Drying time 2 hours.
4. Even out (disperse) with aviation dispersion 7215.00
5. Spray aviation lacquer 7115.02 thinned with aviation thinner 7213.00 in a ratio of 1:1 twice saturated in criss-cross pattern. Drying time 2 hours.
   In standard camouflage shades if applicable.

Single lacquers for aircraft operators and overhaul depots and their application rules

Aviation lacquer 7140.- (transparent green)

This lacquer is used to paint all wooden parts not exposed to air currents, i.e. for wooden interiors.

Aviation lacquer	7140.-
Aviation thinner	7233

Application instructions

1. Remove dust from the dry wood surface.
2. Paint on aviation lacquer 7140.- thinned with aviation thinner 7233.00 in a ratio of 3:2.
   Drying time 3 hours.
3. Spray aviation lacquer 7140.- thinned with

aviation thinner 7233.00 in a ratio of 1:1.
Twice saturated in criss-cross pattern.
Drying time 3 hours in each case.

Aviation lacquer 7122 (single coat lacquer)

This aviation lacquer is essentially intended for painting interiors in shade 02 and for painting exteriors in the standard camouflage shades for aircraft receiving a single coat. It is applied in the usual way but the throughput times in the viscosity meter will vary according to shade.

Aviation lacquer	7122
Aviation single thinner	7200.00

Application instructions

1. Carefully degrease metal surfaces.
2. Spray aviation lacquer 7122 once only criss-cross thinned with aviation thinner 7200.00 in a ratio of 3:1.
   Shade 02 or standard camouflage shades.
   Drying time 3 hours.

Aviation lacquer 7160.21 - 28

This lacquer is suitable for marking pipes and for lettering and national insignia on all surfaces, especially by the spray process.

Aviation lacquer	7160.21-27
Aviation thinner	7232.00

Shades 22-27 correspond to the shades under DIN L 5.

This lacquer must be applied thinned to the necessary extent in each case in accordance with the technical requirements.

Aviation lacquer 7164.21 - 22

This lacquer is used especially for lettering and applying national insignia by the brush-on process, especially on single paints.

Aviation thinner	7234.00

This lacquer must be applied thinned to the necessary extent in each case in accordance with the technical requirements.

Aviation lacquer 7165.21 - 22 (non-flammable)

This lacquer is used for lettering and applying the national insignia on non-flammable paints (lacquer groups 05 or 22 and 33).

Aviation thinner	7232.00 (as for aviation lacquer 7160)

This lacquer must be applied thinned to the necessary extent in each case in accordance with the technical requirements.

Aviation lacquer 7119.- (acid resistant lacquer)

This lacquer is used for additionally treating mountings and all wood and metal parts exposed to acid. The lacquer replaces aviation lacquer 7117.-, which is no longer available, used for the same purpose hitherto after all existing stocks have been used up.

Aviation lacquer - uniform thinner	7200.00

It is applied by single, saturated spraying criss-cross on the prescribed finish thinned in a ratio of 3:5 with aviation thinner 7200.00. Drying time 3 hours.

Aviation lacquer 7136.00

This lacquer is used to insulate painted metal finishes from the lacquering of the fabric drawn across it (e.g. on wings and control surface noses). The lacquer is necessarily sprayed unthinned and has a drying time of 2 hours.

Aviation lacquer 7102.-

Used for the interior painting of welded hollow steel components (fuselage fittings) by filling and pouring out. The lacquer is pumped into the tubular frame at its lowest point necessarily unthinned until it emerges from the highest point. The tubular frame must then be entirely emptied again while tilting (necessary only for naval aircraft and those operated under similar conditions).

Aviation lacquer 7120.22 (removable night camouflage)

This aviation lacquer is applied as required to the underside of the aircraft within the area of shade 65 in accordance with the following special instructions, before the operations concerned. Insulating lacquer JS 238 from Gustav Ruth, Temperolwerke, Hamburg - Wandsbeck should first be thoroughly applied to the standard camouflage in shade 65 to facilitate subsequent removal.

The necessary insulating coat is generally already applied by the manufacturer. Care should be taken that only the underside of the aircraft (area of shade 65) and on no account the dark upper side of the aircraft is treated with insulating lacquer. Aviation lacquer 7120.22 may in any event be applied only in the field.
Application instructions:

Applying insulating coating JS 238

1. Carefully clean the areas to be sprayed with aviation cleaning agent 7238.00. Remove oily

patches with petrol. Oily residues reduce the adhesion of the lacquer. The clean surfaces must be dried throughout before spraying.
2. Stir the insulating lacquer well before applying.
3. The insulating lacquer is ready for spraying and may not be thinned.
4. The lacquer is sprayed saturated criss-cross twice over. The two work steps may follow each other. The drying time for the paint is approx. 6 hours. Allow to dry overnight if possible.
5. All areas and fixtures painted in shade 65 (blue) must be over-sprayed with insulating lacquer.

Preparation of aviation night camouflage 7120.22

A start may be made with applying the camouflage coat after the insulating lacquer has sufficiently dried out.

1. The colour must be thoroughly stirred until it appears grainy and no further bottom deposit exists. Any bottom deposit not stirred up will jeopardise the camouflage effect and put the crew at the greatest risk. Dural tube with the bottom third flattened will be used as stirring rod.
2. The colour is ready for applying. It may not be thinned with aviation thinner, petrol, paraffin, or the like, since this substantially reduces the camouflage effect.
3. Tipping into a bucket or similar container is necessary as the colour is then more easily processed and the bottom deposit can be checked.
4. Seal pots with residual quantities carefully to prevent evaporation.
5. Colour will normally be painted on with normal ceiling rollers. These brushes are soft and pliable and ensure a good coat.
6. Saturated application of colour in the direction of flight moving the roller backwards and forwards once only. Repeated painting on one spot will again remove the colour.
7. Fitches (small brushes) may not be used.
8. Hollows and bare patches allowing the blue base coat to show through must be avoided by full, careful painting.

Applying the camouflage

1. The entire underside must be covered, including all fixtures.
2. Cover wings and control surface leading edges, even if black paint has already been permanently applied. Continue aviation night camouflage paint 7120.22 over the leading edges to approximately ½ metre beyond the surfaces covered.
3. Paint fuselage sides up to the upper edge of the Balkenkreuz.
4. The rudder (including stabilisers) and swastika must be painted over entirely.
5. The Balkenkreuz (white angle and black bars) on the sides of the fuselage and the undersides of the supporting surfaces must be fully covered.
6. Oily patches must be cleaned up without fail before coating.
7. Bare patches occurring must be carefully touched up before each new operation, if the overall coat cannot be renewed.

Removing camouflage paint:

1. The night camouflage must be removed without fail after a maximum of 8 days' operations (or earlier if damage has occurred).
2. The total coat must be removed with rubber scrapers except at oiled points.
3. Points where the black colour has been soiled with oily deposits that have become sticky must be cleaned with wood stopper and washed down with petrol.
4. No work may be done with metal or sharp instruments since this damages the insulating lacquer or base coat and makes subsequent cleaning more difficult.
5. Work in the direction of the wind if possible to prevent dirt from settling on the operator.

Marking of aircraft for night operations

It must be noted with particular care that the Balkenkreuz must be duly applied with washable marking colour 7120.77 without fail to night camouflage applied for night operations.

The white angles in the Balkenkreuz will be omitted! Executing the Balkenkreuz with aviation marking colour 7120.77 in accordance with the following sketch will in no way jeopardise the camouflage effect.

No other colours may be used for this purpose!

The black coat need not be removed entirely for daytime flights within the occupied area and over Germany. The specific nature of the marking colour allows the white angles overpainted with this lacquer to be exposed and a Balkenkreuz to be produced which will be clearly recognised from the ground, even at a great height.

Publisher's Note: Refer overleaf to accompanying sketch of markings of aircraft operating by night.

Aviation Lacquer 7124.22 (permanent night camouflage)

Washable night camouflage in lacquer 7120.22 is not sufficiently proof to weathering at certain points, e.g. on the wings and control surface leading edges, during operational use. Permanent night camouflage paint must therefore be used in some cases in accordance with the following special instruction.

This includes:

Aviation night camouflage undercoat	7123.-
Aviation night camouflage thinner	7205.00

356: *The official diagram showing the application of night camouflage and markings*

Vergleiche nachstehende Skizze.

Note the following sketch.

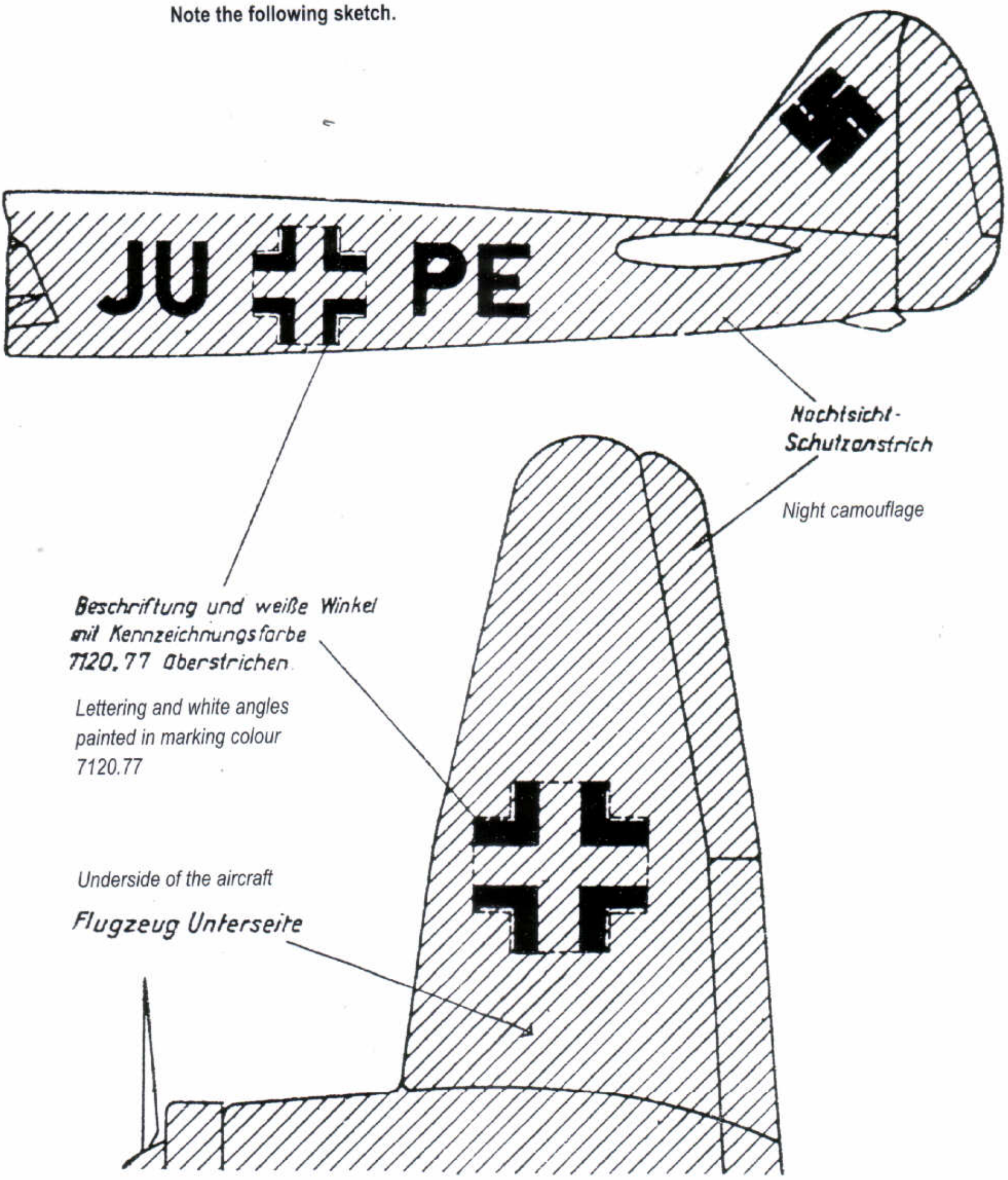


Abb. 1

Anbringung der Kennzeichnung auf Flieglack 7120.22

Fig. 1
Application of markings in aviation lacquer 7120.22

1. Washable night camouflage paint is removed from the supporting surfaces and fuselage.
2. Lightly disperse with aviation cleaning agent Z until the insulating coat begins to dissolve.
3. Areas cleaned in this way must dry for a while after this work step so that the solvent applied can evaporate (at least two hours).
4. Colours must be stirred well until they appear grainy and no further bottom deposit exists. A tube pressed flat at the bottom end must be used as stirring rod. The bottom deposit (pigments) is an important component of the lacquer. The absence of these pigments will jeopardise the camouflage effect and will place the aircraft and its crew at particular risk.
5. Both aviation lacquer 7123.- and aviation lacquer 7124.22 are thinned with thinner 7205.00 in a ratio of 1:1 (by volume). The thinner must be thoroughly stirred into and mixed with the lacquer.
   Since thinned lacquers sediment faster, it must again be thoroughly stirred during application, especially whenever the spray gun is refilled.
6. Thinned aviation night camouflage undercoat 7123, thinned in accordance with step 5, is sprayed once only saturated in criss-cross pattern on the pre-treated surfaces and parts of the aircraft after the work in steps 1 and 2 has been completed.

   Spray pressure 2.5-3 atmospheres
   Spray gun nozzle 2 mm
   Gun distance approx. 250 mm
   Drying time approx. 3 hours

7. After this drying period, the topcoat is applied with the thinned aviation permanent night camouflage colour 7124.22

   Sprayed once saturated criss-cross.
   Spray pressure 2.5-3 atmospheres
   Gun nozzle 2 mm
   Gun distance approx. 250 mm

8. The permanent night camouflage colour 7124.22 is misted on immediately after work step 7 without any particular drying time, i.e. it is sprayed on to the still wet coat with the same spray gun but at a spray pressure of approx. 5 atmospheres and a gun distance of 500 to 600 mm. The process must necessarily be started at the same point where saturation spraying was started under step 7 in order to avoid the two coats from merging if the paint is not sufficiently dry.

   Misting is kept to a minimum in order to achieve a finely grained surface.
   Lengthy misting is necessary for a rough surface.
   The drying time before operations is approx. 3 hours, preferably in the hanger overnight.

9. The washable aviation night camouflage colour 7120.22 is applied on the remaining two-thirds of the underside of the aircraft (see picture below).

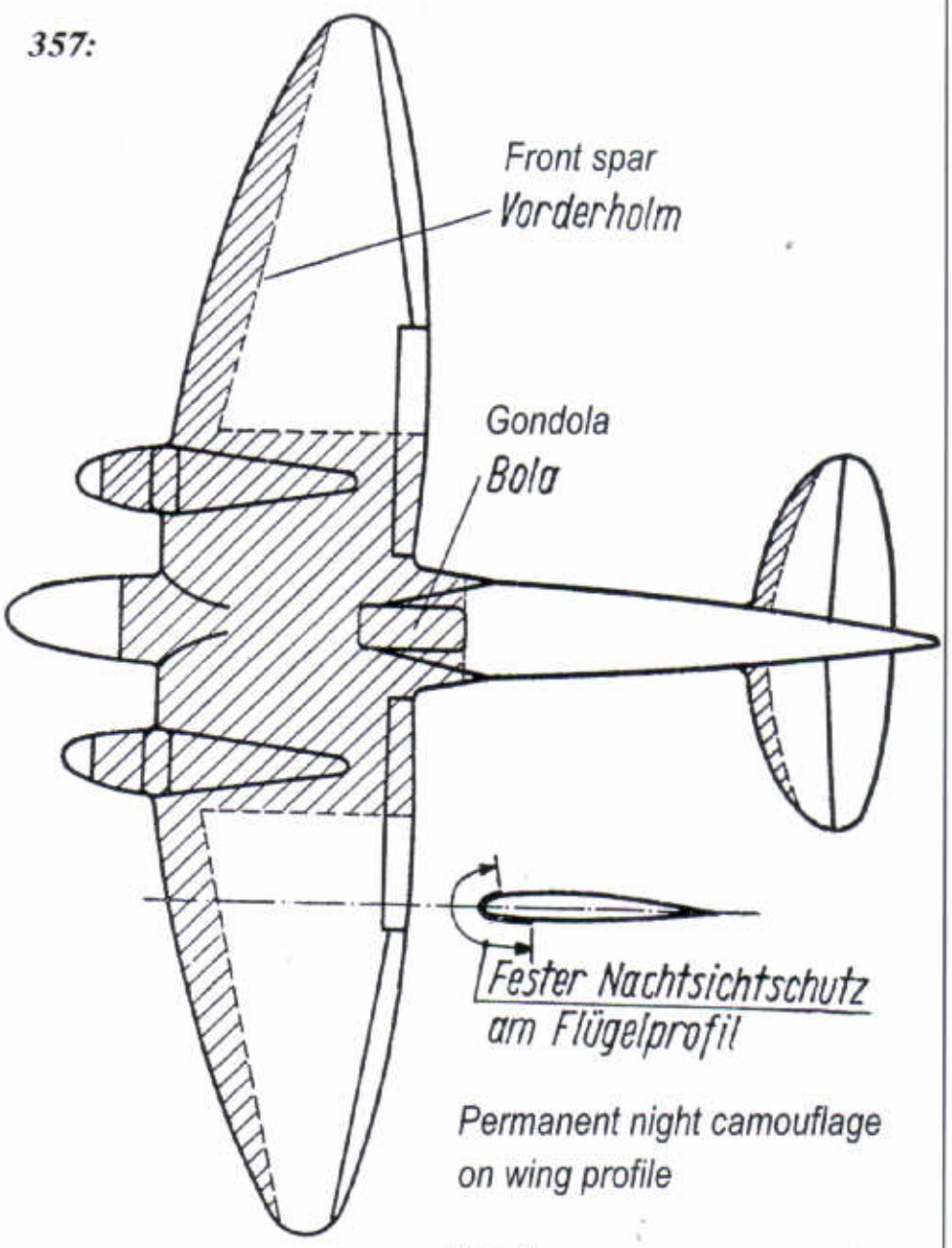


Abb. 2
Flugzeug-Unterseite.
Anbringung des festen Nachtsichtschutzes (schraffiert)

Fig. 2
Aircraft underside.
Application of permanent night camouflage (hatched)

Aviation lacquer 7146 (propeller paint)

This lacquer with its associated primer is used to paint metal air screws and may be applied only by the air screw manufacturer in accordance with the following Instruction. The aviation industry may not apply paint to propellers and this may be done in the field only if proper balancing is ensured.

Aviation lacquer	7142
Aviation thinner	7200.00

Application instructions

1. The air screws must be carefully degreased.
2. Thinly spray aviation lacquer 7142.- once only thinned with aviation thinner 7200.00 in a ratio of 4:5.
   Drying time 1 hour.
3. Spray aviation lacquer 7146.71 once only criss-cross thinned with aviation thinner 7200.00 in a ratio of 1:1

4. Spray aviation lacquer 7146.70 once only criss-cross thinned with aviation thinner 7200.00 in a ratio of 1:1.

Aviation lacquer 7111.-

This lacquer may be used only for preserving rivet sets on anodised aluminium and also for painting non-anodised sheet used for necessary repairs on otherwise fully anodised aircraft. The lacquer is supplied in transparent yellow approximately equal to the shade of the anodised parts.
Use aviation uniform thinner 7200.00.
The lacquer must be applied by brushing unthinned or thinned in a ratio of 1:1 with a passing time (3mm) of 40 seconds. Observe three hours drying time.

Aviation lacquer 7118.-

This lacquer may be used only for dipping (or occasional spraying) of anodised, sealed light alloys on mass produced naval aircraft. It is used to strengthen scuff protection of anodised parts on naval aircraft and ensures improved cleaning of these parts before painting. The lacquer is coloured a transparent blue to distinguish it from untreated surfaces. Use aviation uniform thinner 7200.00.

The lacquer is applied by dipping the anodised, sealed parts immediately after drying once in the unthinned lacquer or spraying them with the latter.
Drying time one hour.

Sealing compounds

The aviation materials listed below are required for sealing metal joints and other aircraft joints and for riveting floats and flying boats.

For floats and flying boats:

Aviation binder	7260.-
Aviation adhesive paste	7265.-
Aviation jointing paste	7264.-
Aviation paste cleaner	7235.-

For wing-tip tanks and fuel containers subject to particularly high stress:

Petrol resistant	=	Aviation binder 7263.- Aviation sealing paste 7261.-
Fuel resistant	=	Aviation sealing paste 7262.- Paste cleaner 7235.-

Metal treatment to be applied in all cases:

1. The metal strips and parts to be joined are cut to shape, packed and drilled at the riveting points.
2. The parts to be anodised are anodised and immediately sprayed with transparent blue dipping lacquer 7118.- or dipped. Minimum drying time: 4 hours.
3. Non-anodised metals at the rivet edges are essentially left bare.

Sealing floats and flying boats:

1. Heat the aviation sealing paste 7265.- to approx. 40°C in the application device. The water bath contained in the device is heated electrically. There is no objection to gas heating of specific devices. The water bath is subject to regulation.
2. Aviation adhesive paste 7265.- is applied to both sides of aviation binder 7260.- with the application device. The layer thickness must be sufficient to ensure a good seal between the tape and work piece.
3. The pasted aviation binder 7260.- is placed tight and uncreased to the metal strips to be riveted. Rounded parts and edges must where necessary be cut from a wider piece of silver tape.
4. The second metal strip is laid out and pre-riveted tight or fastened with a bolt.
5. The rivet holes in the tape should essentially not be drilled. These should be punched through with an awl so that any tape fibres inside are not pulled out. In cases where the metal must be subsequently drilled, a high-speed drill should be used as fibre loss is possible on slow drilling through the tape.
6. Careful riveting of the parts. Poor riveting necessitates complicated reworking.
7. The water test is carried out immediately after riveting.
8. Individual untight rivets must be replaced or tightened up; if work is properly done, no untight riveted joints will occur.
9. Mechanical removal of the surplus adhesive paste using a wooden mortar knife. Cleaning down with paste cleaner. Any tape edges showing must be carefully cut away.
10. Further sealing of the cleaned exterior and interior seams with jointing paste 7264.-. This is applied with a small pressure jet (confectioner's syringe). It is unlikely that interior seams will need further sealing if the riveting has been carefully done. It merely makes for further safety.
11. Preservation follows as instructed.

Sealing of wing tanks and fuel containers

Metal surfaces are pre-treated as under A above. It must be noted that the sheet earmarked for fuel tanks must remain free of any kind of paint preservation at the riveted edges.

1. Adhesive paste 7261.- is lightly heated in a water bath to make it more malleable. It may on no account be thinned with any kind of thinner.

2. The paste is applied in uniform thickness to the two pre-drilled riveting strips to be joined together using a putty knife.
3. Aviation binder 7260.- must be played tight and uncreased on a metal strip to which paste has been applied and pressed down. The second metal strip to which paste has been applied is now pressed down with clips or bolts.
4. The rivet holes in the tape should essentially not be drilled. These should be punched through with an awl so that any tape fibres inside are not pulled out. In cases where the metal must be subsequently drilled, a high-speed drill should be used as fibre loss is possible on slow drilling through the tape.
5. Careful riveting of the parts. Poor riveting necessitates complicated reworking.
6. Mechanical removal of the surplus adhesive paste using a wooden mortar knife. Cleaning down with paste cleaner. Any tape edges showing must be carefully cut away.
7. The cleaned exterior and interior seams are further sealed, namely
   Exterior with jointing paste 7264.-
   Interior with jointing paste 7262.-

The paste is applied with a small pressure spray (confectioner's syringe).

Instructions for using the tape machine

Proper application of aviation adhesive 7265.- to the aviation binder 7260.- is essential for a smooth seal. The tape is laid in the machine in accordance with the following sketch, the upper chamber, i.e. that containing the tape, is subsequently filled with aviation adhesive 7265.- until the tape and the guide rollers are fully covered with paste. The lower chamber, the water bath or oil bath, must be continuously filled with water up to the overflow opening. To start up the machine, the water or preferably the oil bath is heated up to approximately 40° C by setting the two switches at heating level 3. After the paste has been uniformly heated up and is sufficiently pliable for application, sealing may commence. To achieve faster, uniform heating and to avoid overheating locally, the paste is repeatedly stirred strongly with a stirring rod. The switch is now set at level 1, one switch being switched off completely if necessary (level 0). On no account may the paste be overheated. Signs of this are small or large bubbles rising through the paste. Knobs to the left and right automatically switch off the current when 100° C is reached and are intended solely to ensure the safety of the electrical heater.

The thickness gauge must be so adjusted beforehand using the built-in set screws that a layer of paste 0.2 to 0.3 mm thick is applied to each side of the tape. The tapes are slowly and uniformly drawn from the outlet opening with pliers and cut to the desired length. Make sure that new tape is joined to the end of the old roll as it is about to run out.

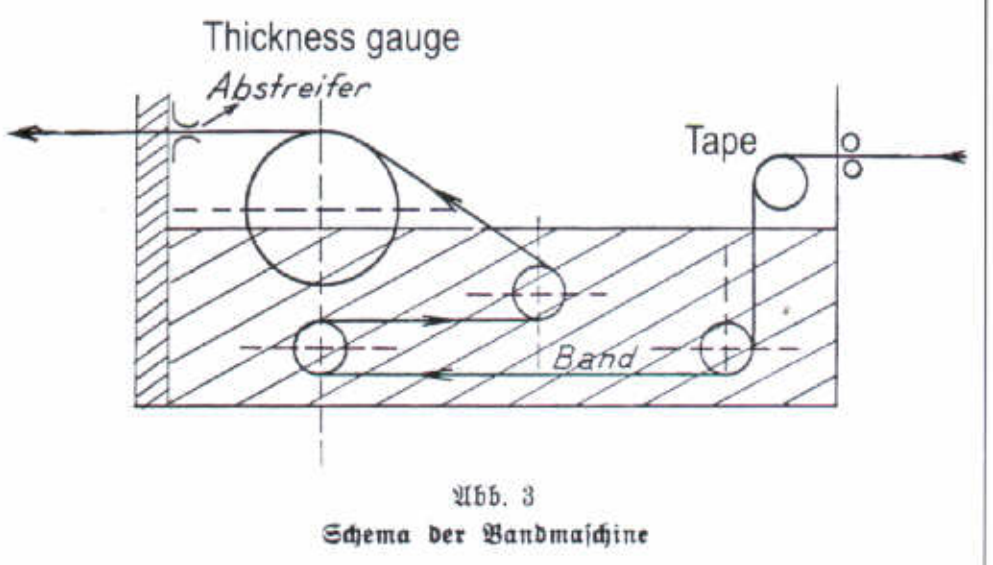


Abb. 3
Schema der Bandmaschine

Fig. 3
Diagram of the Taping Machine

Identification of paints used

On the aircraft

A reference to the type of lacquering used will be applied in the briefest form on the starboard side of the rear of the fuselage next to the aircraft data. In the case of mass produced aircraft, an indication of the date on which painting was completed and of the lacquers chiefly used will suffice, e.g.

Painted on 1.7.40
Metal: Aviation lacquer 7122.65/70/71
Wood: lacquer group 30
Fabric: lacquer group 20

Where different paints have been used on assemblies, the information must be provided for each assembly. The information on prototype aircraft and on aircraft finished in paints for testing will be provided in the following form:

Experimental paint aircraft

Painted on 15.8.1939
Metal: Lehman & Co. - AS 420
Fabric: A. Meyer - 17c32
Surface protection - see list.

Paintwork repairs other than those resulting from the natural wear and tear of the coating will be entered on the aircraft log by the keeper. Details must include the date of the repair, the area repaired and the lacquer used. The information on the fuselage must be corrected following major overhauls of the lacquering. Particular behaviour of a lacquer must be entered on the aircraft log and reported to RLM GL/C-E2 VII.

In the aircraft log

The lacquers used will in principle be entered in the

aircraft log in the form prescribed by the Surface Protection List ['OS List']. Apart from experimental and special coatings, the List will include all information on normal mass produced paints of importance with regard to surface protection for the aircraft keeper. The contents will be kept as brief and clear as possible. Application procedures that the keeper cannot observe or apply through the absence of appropriate equipment need not be recorded on the List since the part concerned is essentially procured as a ready-to-fit spare. To avoid an extended form having to be drawn up for use by the aircraft industry in addition to the abbreviated form in the Surface Protection List, production information which is of no interest to the keeper will be issued separately in the form of internal operating instructions.

In the case of experimental lacquers, the Surface Protection List will primarily contain information on repairs to the aviation lacquers used. A lacquer system adopted experimentally will be used only as a last resort.

The Surface Protection Lists must in all cases be submitted to the RLM for approval and counter-signing.

Application of Lacquers and Lacquer Groups

The appropriate lacquers and lacquer groups will comply with the nature of the material to be treated and its intended purpose and the intended purpose of the aircraft to be painted (see Annex 5). In addition, the nature of the aircraft to be treated will determine the shade of the exterior paintwork. The appropriate lacquer will be selected according to whether the component to be treated is internal or external (i.e. whether or not it is exposed to the free airflow). In the case of materials, a distinction should be made with a view to corrosion prevention between:

1. Fabric
2. Plywood and solid wood
3. Heavy metals
4. Light metals
   a) magnesium alloys
   b) aluminium alloys
   c) alloys of the hydronalium type
5. Plastics.

It is essential that metals are protected before they are painted. This includes anodising (and similar chemical processes), cladding (by galvanising or mechanical means) and additives to the material itself to control its corrosion behaviour.
A distinction will be made for application purposes between:

1. Land aircraft
2. Land aircraft to be used over water
3. Naval aircraft
4. Tropical aircraft
5. Carrier-borne aircraft (non-flammable paint).

The shade to be used for exterior painting will depend on whether the aircraft is a:

a) Trainer (standard finish)
b) Fighter (shades 74, 75, 76 and 65)
c) Destroyer [Zerstörer] (as b)
d) Bomber or transport aircraft (shades 70, 71 and 65)
e) Naval aircraft (shades 73, 72 and 65)
f) Tropical aircraft (shades 78, 79 and 80).

The surface protection procedure adopted may be inferred from the overview (Annex 5). The following rules are common to all aircraft:

- Light metal tubing and welded steel tubes should be painted by filling and emptying with aviation lacquer 7102.-, provided that interior protection is necessary and no special rules apply (e.g. regarding respirators).
- Aviation sealant 7264.- will be used for sealing riveted seams on land aircraft for weather protection and moisture proofing.
- Working surfaces (surfaces intended to slide over each other) will not be painted but treated with the prescribed grease, i.e. if not prescribed otherwise an acid-free grease such as high pressure grease red from Shell. Working surfaces may be marked off against the lacquering with a red line 3mm wide.
- Walkable surfaces must be separated from non-walkable by a broken line 10 mm wide (painted length 20 mm), distance 20mm, aviation lacquer 7160.23. The words "Nur hier betreten!" ["Walk here only"] to be stencilled within this area in bold letters (DIN 1451) 25 mm tall. The words "Nicht anfassen!" ["Don't touch"] will be applied to sensitive parts such as trimming flaps. If the walkable parts of the sheeting predominate, the existing procedure will continue to apply.
- Bracing wires and controls will be painted as for other metals, there being no need to mark the thread ends. Grease cables only if necessary.
- Spliced cable ends will be dipped in finished state for 30 minutes in hot, thin liquid aviation paste 7242.- so that the splice is saturated. No further painting is necessary.
- Electrical bridging must finish on bare metal and may only then be painted (see the special instructions for frame connections). Current transfer points must be left bare. Electrical contacts and plugged connections on tropical aircraft must be protected against humidity with aviation lacquer 7151 after the connection is made.
- Tubing (exterior only) and lettering will be painted and the national insignia and military markings

applied with aviation lacquers 7160.21-27 or 7164.21 to 22 or 7165.22 (non-flammable). Identification tapes from Beiersdorf, Hamburg, conforming to DIN L 5 may be used on uniform lacquering in shade 02. Minor departures from the RLM colour chart are permitted for tubing.

- Metal air screws will be painted with aviation lacquers 7142 and 7146 as prescribed, if acceptable.
- Aviation lacquer 7119.- will be used as the last topcoat as acid protection for battery mountings (stocks of aviation lacquer 7117.02 must be used up).
- Inaccessible points, angles and corners and those easily exposed to decay may additionally be coated with aviation sealant 7243 after painting is completed.
- Exhaust pipes need merely be rubbed down with engine oil. Kemik Schwarz (chemical black) paint from G. Collardin, Cologne Braunsfeld, may be used.
- Painted parts affected by soiling or oil must be cleaned with aviation lacquer cleaning agent 7238 as prescribed by the manufacturer.
- Instrument panels and the interior of glazed cockpits of combat aircraft will in principle be painted with the prescribed lacquer, but in shade 66.

Use of lacquers

Delivery conditions for lacquers

a) to be supplied in containers that permit easy mixing, pouring and proper storage.

b) Markings on containers must be water-proof and resistant to lacquer spills.

c) Delivery to be made in two separate components: "Unthinned" and "thinner". The thinner will be that prescribed for the lacquer. The mixing ratio for each kind of application must be specially indicated.

d) The legend will include:
i) the name and address of the paint manufacturer
ii) the number of the lacquer or thinner as prescribed, e.g. "Aviation lacquer 7107.02"
iii) the range of application and group of the lacquer in brackets, e.g. (unthinned lacquer for metal, Aviation lacquer system 04)
iv) sprayable in .... Parts by volume
dippable in .... Parts by volume,
brushable in .... Parts by volume
mix unthinned lacquer with aviation lacquer thinner No. ... with 1 part by volume and apply as instructed
v) delivery date.
The word "unthinned" will be printed across the legend in red.

e) "d" does not apply to thinners (Nos. 200 - 239) or sealing compounds.

f) lacquers containing dirt particles (sieve!) must be returned.

Lacquer storage and preparation

The temperature in lacquer stores may not be less than +5° C.
Lacquers stored separately must be stirred for 30 minutes after the two components have been mixed in the prescribed ratio with the stirrer from Brea GmbH Jena or equivalent and be ready for application when the ambient temperature is reached. Adequate preparation will be checked by continuous measurement in a viscosity meter with 3 mm opening (from Franz Hering, Jenaer Apparatebauanstalt, Jena) at 18-21° C.

The pouring beakers with 3 mm nozzle introduced in the Luftwaffe will be replaced in the foreseeable future with the standard pouring beaker under DIN 53211 with a 4 mm nozzle. The pouring times for 4 mm nozzles must therefore also be indicated in L.Dv 521/1 in each case.

Cleaning of construction materials

a) Metal surfaces will be cleaned with
i) perchlorethylene (Dr Alexander Wacker GmbH, Munich) in permanent installations

ii) P3 Almeco (Henkel und Cie AG, Dusseldorf) in permanent installations

iii) aviation cleaning agent Z (Warnecke & Böhm A.G. Berlin - Weissensee, Goethestr.) for manual application

and must be dried before painting.

b) Wood may be cleaned only on visible soiling (rubbed down with emery paper 000). Highly soiled fabric must be returned to the manufacturer.

c) Painted materials must be treated with the appropriate substances and not with the cleaners indicated above (see Rules for Paint Care).

d) P3 (Henkel und Cie. A.G. Dusseldorf) or strippers may not be used to clean built-in unpainted or painted materials.

Painting generally

a) Lacquer application
Lacquers will in principle be applied in accordance with the instructions for use. Separately stored lacquers are ready for use when processed.
Principle:
Lacquers will be so sprayed or brushed that a flawless coat is achieved. Enamels may be used only with prior

RLM approval and will be so applied that temperatures of 100 C and baking periods of five hours are not exceeded for materials of the Duralumin type (aviation materials Nos. 3100 - 3199) or temperatures of 200° C and baking periods of two hours for all other metals.

Scrupulous cleanliness will be observed in the paintshop and when handling lacquered parts. Unless the processing instructions and, especially, the drying periods are closely observed, flawless lacquering cannot be achieved. Haste in lacquering work will only result in delays, as the lacquering will have to be repeated.

b) Appropriate shade.
Exterior
Shade as for topcoat: always use standard finishes 65, 70, 71 etc. up to 80 in accordance with operational requirements or the intended use of the aircraft. Standard finish will be applied accordingly to trainers. Experimental aircraft may be painted on the outside in shade 02 as from the first prototype. Shade 01 may not be used.
Interiors
Interiors will in principle be painted in shade 02. Shade 01 may not be used here, either. Only the interior walls of glazed cockpits and canopies may be protected against dazzle in shade 66 (corresponds to RAL shade 7021).

c) Special working conditions
1. Naked flame, smoking and the presence of glow-type heaters ('solar' radiators) are fatal in paintwork shops and are therefore prohibited.
2. Lacquers will be applied by:
spraying with a spray-gun with 1.8-2.5 mm jets at working pressures of 3-4 atmospheres (normal application).
brushing
dipping
coating and subsequent pouring off (for hollow articles).
Normal application of a coat:
Spraying once only in criss-cross pattern, i.e.
The area to be painted is either first pre-sprayed in one direction and at right angles thereto immediately afterwards or, preferably, the entire article first in one direction and then at right angles thereto after initial drying.
3. Paint will be applied in paint shops at temperatures at 18-25° C for air and paint and at a relative air humidity of 50-75%. The climate will be continuously monitored with surf-scribing devices. Strip charts will be retained.
No special paint shop is necessary for minor repairs. An enclosed space suffices. Higher temperatures may be used to speed up paint drying only with prior RLM approval.
4. Paint will be applied in completely dust-free and mist-free environments. Paint mist must be prevented from settling in aircraft parts in all circumstances. Paint shops must be provided with proper exhaust systems. Local horizontal booth exhausting is adequate for minor work but vertical exhausting to the rear is applied for major work.

Special painting rules
a. Surplus sealant settling on metal on sealing rivet sets must be immediately removed and not left until further preservation.
b. Wet and sharp dry sanding are permitted for special purposes and only with RLM-GL/C-E2 VII approval.
c. The number of prescribed work processes and the prescribed drying times must be strictly observed.
d. Metal structures, supporting surfaces, fuselages etc. must always be earthed before spraying is commenced.
e. Inaccessible areas must be finally painted before assembly. Successive coats must always be applied with a run-off to areas where the connecting sections are ready painted after assembly to enable any subsequent coat to be applied without problems. For example:

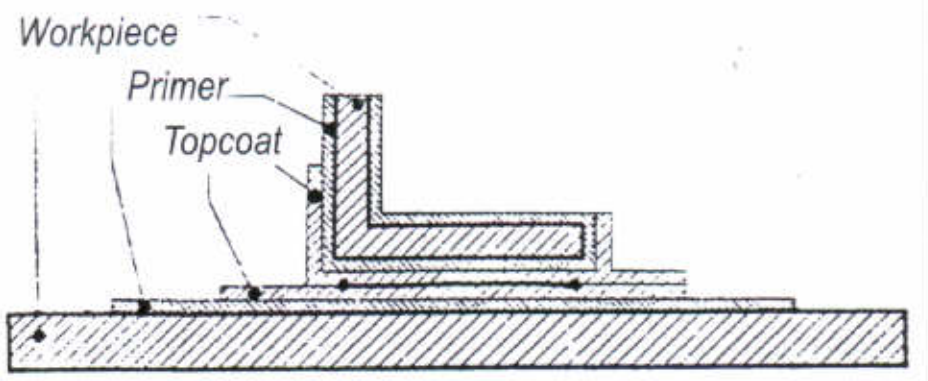


Fig.4
Painting Scheme

A single coat of the primer from the prescribed lacquer group on each seam surface is sufficient for preserving riveted seams. The primer for a metal system may conveniently be applied as soon as work shop processing commences if careful treatment of prepainted parts is to be guaranteed (Cleaned! Grease-free!).
f. Plastic wood may be used for filling minor damage to wooden parts before the lacquer is applied. The first coat may be applied only after careful drying. The workshop management's consent must be obtained beforehand when using plastic wood.
g. Stopping may not be used without express RLM-GL/C-E2 VII consent beforehand.
h. Accidentally soiled metal and wood lacquers (primer) may be cleaned with a very fine steel wall (No. 00). The surface of the metal or wood may not be damaged in consequence and paint removed must be replaced. Residues of steel wool must be removed without trace.
i. Painting errors must be reported to the workshop

management immediately on detection for remedying.

k. Appearance of finished paintwork: the surface of the finished lacquering must be as dull as possible. Gloss or high gloss may be used for painting aircraft only with special RLM-GL/C-E2 VII approval.

Treatment of fresh aviation paintwork

1. Paint may be fully exposed to the weather not less than 48 hours after the last coat has been applied. Flying boats and seaplanes may not be launched until 72 hours following completion of painting and left permanently in the water only 14 days following completion. Time in the water is limited to 8 hours per day from the third to the fourteenth days.

2. To ensure a matt finish to the exterior in the standard camouflage colours, and the consequent, indispensable low reflected values for the paint, the finished paintwork on the aircraft may not be "touched up" until further notice.

Exceptions are permitted only with the express consent of RLM GL/C-E2 VII for mixed construction aircraft which are exposed to extreme stress. Generally speaking, only cleaning of soiled exterior paintwork is permitted with aviation cleaning agent 7238.- in accordance with the following regulation.

Application instructions for aviation cleaning agent 7238.-

Stir well before use! The soiled areas are rubbed down with a sponge or a soft rag with 7238.- thinned with water in a ratio of 4:1. This is washed down with clean water after 15 minutes and rubbed dry. Patches of hardened oil may be rubbed down with concentrated 7238.-. Further treatment as above. Water must be carefully blown out of riveted seams and other hollows spaces with compressed air before initial painting.

RLM Rules for cleaning metal parts

RLM Rules for cleaning metal parts in permanent installations with perchloroethylene (Per)

1) Installations:

Degreasing installations from A. Bader, Munich, are used for cleaning. The size of the installation depends on the amount of material to be passed through in each case. The installations consist of:

a) A washing bath. Three washbasins in which the parts to be decreased are suspended using wire baskets are arranged next to each other in a large external frame. A cooling installation provided with running mains water runs along the top part of the frame internally and serves to precipitate the evaporating PER.

Each basin contains 30 litres of PER, which is heated to +90C through built-in steam hoses.

b) Distillation plant. This is used for cleaning or recovering perchloroethylene containing grease.

2) Operating method:

Per is a very sharp solvent for grease, oils, resins and lacquers and removes the substances from metal parts without trace after an application period of appropriate length. Per is non-flammable!

3) Working procedure:

i. Place the parts to be degreased in the wire baskets.

ii. Suspend the first basket in the first washbasin, and then in the second and finally in the third. Exposure in the first basin 5 minutes, in the second and third a brief dip. Ongoing process.

iii. Dip the basket from the third basin to just beneath the top edge of the frame. The metal parts are dried immediately by their specific heat.

iv. Removal of the wire baskets and passing on of parts for painting or anodizing.

v. The perchloroethylene must be pumped out of the washbasins into the distillation plant daily (see 1b) and the per distilled off to remove impurities.

RLM Rules for cleaning metal parts with aviation cleaning agent Z

The metal parts from which paint has previously been removed with stripper or bare metal parts are thoroughly degreased with aviation cleaning agent Z.

The procedure to be adopted is as follows:

1. Clean soft rags will be wetted thoroughly with aviation cleaning agent Z.
2. Each square metre of area to be degreased will be rubbed down carefully with the well-soaked rags.
3. Rub dry immediately afterwards with clean, soft rags.
4. When degreasing individual parts, the procedure under 1-3 must be carefully followed but each individual part must be rubbed down immediately with a dry rag after greasing.
5. If parts are badly soiled or covered with oil, degreasing must be repeated if applicable.

RLM Rules for cleaning light metal parts in P3 almeco.

Preparation of the baths:

7 kg P3 almeco for every 100 l of warm water bath (almeco per 100 l where possible).

Ongoing bath testing:

Prescribed concentration = 5-7% (corresponding to 5-7 kg P3 almeco per 100 l water).

Testing and increasing to 5-7% at intervals of 2-7 days, depending on use.

Sampling at working temperature.

Test procedure as prescribed by Henkel & Cie, Dusseldorf "Schnellbestimmung der P3 - Konzentration" ["Rapid determination of P3 concentration"] (Insert factor for "P3 almeco").

Testing device from Greiner & Frisch, Dusseldorf, Hüttenstrasse 144 (Price 7.50 Reichsmark).
Testing with an aerometer will not suffice because impurities are also measured.

Scope of the installation:

1. Iron bath with steam hose or gas or electrical heating to 80-95° C continuous temperature. Size depending on dimensions and quantity of parts to be cleaned.
2. Iron bath with running cold water (ordinary tap water suffices).
3. Iron bath with heating device as item 1 but to 70-80° C.
4. Drying kiln or hot plate where possible.

Procedure:
Dip parts briefly in P3 almeco solution heated to 80-95° C (for 1 to max. 5 minutes), scrub down with fibre brush, rinse thoroughly in running cold water, rinse down in hot water at 70-80° C and leave to dry (in drying kiln or on hotplate if possible). Wipe down with rags only if drying proves insufficient or if insufficient rinsing leaves a white deposit. All light metals can be cleaned in P3 almeco. However, a special bath must be used for electron, in which no other metals may be cleaned.

RLM Rules for cleaning light metal parts in siliron WL.

Preparation of baths:
3-5 kg Siliron WL are dissolved in hot water (over 40° C if possible) while stirring per 100 l of bath liquid.

Ongoing bath testing:
The prescribed concentration = 3-5% (corresponding to 3-5 kg siliron WL per 100 l water)

Specific gravity of 3% solution at 20° C = 1,023
Specific gravity of 5% solution at 20° C = 1,037

An aereometer can be used for further testing of freshly prepared solution only since dissolved impurities influence the result in used solutions. The concentration of the bath liquid must be tested at intervals of 3 days by titration, depending on throughput. Samples will be taken at working temperature. 38.5 cm3 n/10 acid is consumed for every 10 cm3 of 3% siliron WL solution at 20° C (methyl orange as indicator). 63.8 cm3 n/10 acid is used for every 10 cm3 of 5% siliron WL solution at 20° C.
Titration instructions and table follow at the end of these Rules.

Scope of the installation:
As for RLM cleaning with P3 almeco.
An iron grille should be placed on the bottom of the iron bars to prevent the parts to be cleaned from entering into contact with deposited sludge.

Procedure:
The parts to be cleaned are placed in the siliron WL bath, which will have been raised to a temperature of 70-80° C, and left in it for 5-10 minutes depending on the extent of soiling. They are then placed without intermediate drying in the cold water bath in which they are thoroughly rinsed. Smaller and medium-sized parts may be usefully placed in the cleaning and rinsing baths in an iron basket. They are transferred to a hot water rinsing bath at 70-80° C after rinsing in running cold water. The specific heat of the parts removed from the hot water bath is generally sufficient to ensure rapid drying. They must otherwise be further dried on a hot plate or in a drying kiln.

Parts need be wiped down with a clean rag only if inadequately rinsed and consequently displaying white deposits.

Titration:
The bars are titrated as follows if undertaken with n/10 acid.
10 ccm bath liquid cooled to room temperature is removed with a pipette and transferred to a glass beaker. It is diluted with approx. 100 ccm distilled water and 3-4 drops of methyl orange are added as indicator. The indicator colours the alkaline siliron solution a pale yellow. n/10 acid is then added slowly from a burette until the pale yellow colour changes clearly to red. The ccm of n/10 acid used is now read off and the number obtained is multiplied by 0.4. The result shows the alkaline titre, calculated as NaOH grams per litre of siliron solution. The percentage content of siliron can then be read off from the table provided.

In addition to titration with n/10 acid solution or sulphuric acid, any other adjusted acid can be used. If, for example, n/1 acid is titrated and 10 ccm bath liquid is taken, less ccm are used than for n/10 acid, namely one tenth. To ascertain the alkaline titre, calculated as NaOH, the ccm used of n/1 acid must be multiplied by 4.0. Titration with acids stronger than n/10 is advisable if the bath liquid is discoloured through dirt and impurities. The change in the colour of the methyl orange can then be more easily seen.

Table for determining the alkaline titre or the specific gravity of siliron solutions

Siliron Mark	% content	ccm used of n/10 acid	Alkaline titre calculated as NaOH (Methyl orange as indicator) grams per litre	Specific gravity (at 20¡C)	Degrees B (at 20¡C)
Siliron WL	1	12.8	5.5	1,007	1.0
	2	25.7	10.2	1,016	2.2
	3	38.5	15.3	1,023	3.2
	4	51.2	20.4	1,030	4.1
	5	63.8	25.5	1,037	5.0

Recamouflaging aircraft from permanent night camouflage coatings to day camouflage and vice versa

With the introduction of permanent night camouflage, ground units will at the same time retain the blue recamouflaging colour for daytime protection. The blue camouflage will permit the remaining part of the aircraft, which is permanently painted black, to be recamouflaged to blue for daytime use within the shortest possible time after the temporary coating has been removed.

The special composition of the recamouflaging paint also allows the aircraft to be returned to night time use simply by over-spraying the blue camouflage with the night camouflage topcoat.

The increase in the thickness of the paint by applying the blue recamouflaging colour and subsequently the black topcoat is so slight (1 blue coat and 1 black coat amount to less than 0.1 mm) that the aircraft can be recamouflaged up to 15 times or so (blue/black, blue/black, etc.) without special attention. The aircraft will by then be largely ready for partial or major overhaul. Parts covered with permanent night camouflage must be stripped and repainted in accordance with L.Dv 521/3. The night camouflage must then be reapplied if necessary. The increase in weight following one blue coat and one black coat for covering e.g. an He111 is less than 10 kg. Since the recamouflaging process can be repeated several times over, any aircraft can be put to both daytime and night time use.

Directions and instructions for converting permanent night camouflage to day camouflage and vice versa.
Permanent night camouflage will be applied to the leading edges, engine cowlings, spinners, etc. and removable night camouflage to the remaining two-thirds of the underside of the aircraft. Aircraft thus painted may under no circumstances be put to daytime use since any black on the underside appreciably reduces the camouflage effect during the day and thereby places both aircraft and crew at particular risk.

Recamouflaging for daytime use requires:
1. Removable night camouflage will be washed off as before. There is no need for wet wiping down with petrol, water, etc. since experiments have shown that if the leading edges are blue, slight soiling of the blue paint on the rest of the underside of the aircraft does not substantially affect the daytime camouflage.
2. There is no particular need to clean the permanent night camouflage. Any large oily patches can be removed easily with petrol.
3. The recamouflaging colour aviation lacquer 7125.65 is used for recamouflaging. An He 111 requires approx. 10 kg.
4. The recamouflaging colour must be stirred well before use until it appears grainy and no further bottom deposit exists. Unmixed bottom deposit jeopardise the hiding power of the paint and consequently the camouflage effect.
5. The recamouflaging colour is ready to use. On no account may it be thinned with aviation thinner, petrol, fuel, paraffin, etc.
6. Containers with residues must be carefully sealed to prevent evaporation.
7. The recamouflaging colour must be applied with ceiling brushes. The bristles on these brushes are soft and permit colour to be spread effectively in the direction of flight.
8. Drying time approx. 1-2 hours depending on the weather.
9. The aircraft is ready for use even if not thoroughly dry (touch dry only).

On completion of a day-time mission or if preparations for a day-time mission are suspended, the aircraft is prepared for night-time use as follows:
1. The blue camouflage must be completely dry before night camouflage can be applied. This is especially so following a change in flying orders.
2. Any patches of oil can easily be removed beforehand with petrol.
3. The permanent night camouflage paint 7124.22 is applied thinned in a ratio of 1:1 (by weight) with aviation thinner 7205.00 without prior preparation of the blue substrate.
Sprayed once saturated in criss-cross pattern directly on the blue base, without previous application of undercoat 7123.-
Spray pressure 2.5 to 3 atmospheres
Gun nozzle opening 2 mm

Gun distance approx. 250 mm

4. Misting with black topcoat is unnecessary in this case as the desired camouflage effect is already achieved through saturated spraying.

5. The removable night camouflage colour 7120.22 is applied to the remaining two-thirds of the underside of the aircraft following step 3.

6. Drying time approx. 1 hour.

The above recamouflaging from:

night camouflage to day camouflage

and conversely from:

day camouflage to night camouflage

can be repeated several times over.

358:

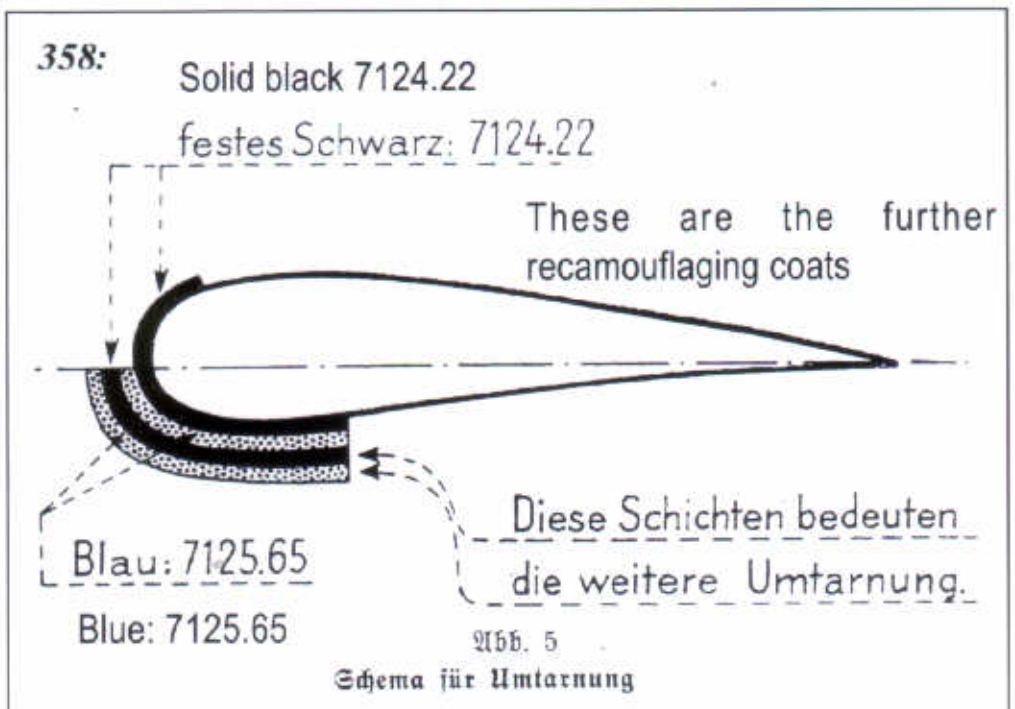


Fig. 5
Recamouflaging diagram

Condition and care of blue camouflage paint on the underside for daytime use

Detailed investigation and reports from combat units show that the blue camouflage on the underside of the aircraft must be checked and serviced in accordance with the following guidelines.

Guidelines

1. The blue paint must be largely retained in its original colour during daytime use for camouflage purposes. This applies especially to the leading edges. The blue paint makes it very difficult for the enemy to detect approaching aircraft. All black areas of the underside must be removed, with the exception of the black parts of the Gothic cross.

2. Reports from combat units have shown that cleaning is facilitated if the exhaust trails on the underside of the aircraft are painted black. This was done by painting not only the exhaust trail itself but also a much wider part of the underside of the aircraft a deep black, thereby jeopardising the camouflage effect on daytime use. This puts the aircraft and crew at great risk.

3. Exhaust trails that have been painted black must be immediately sprayed blue with aviation lacquer 7122.65.

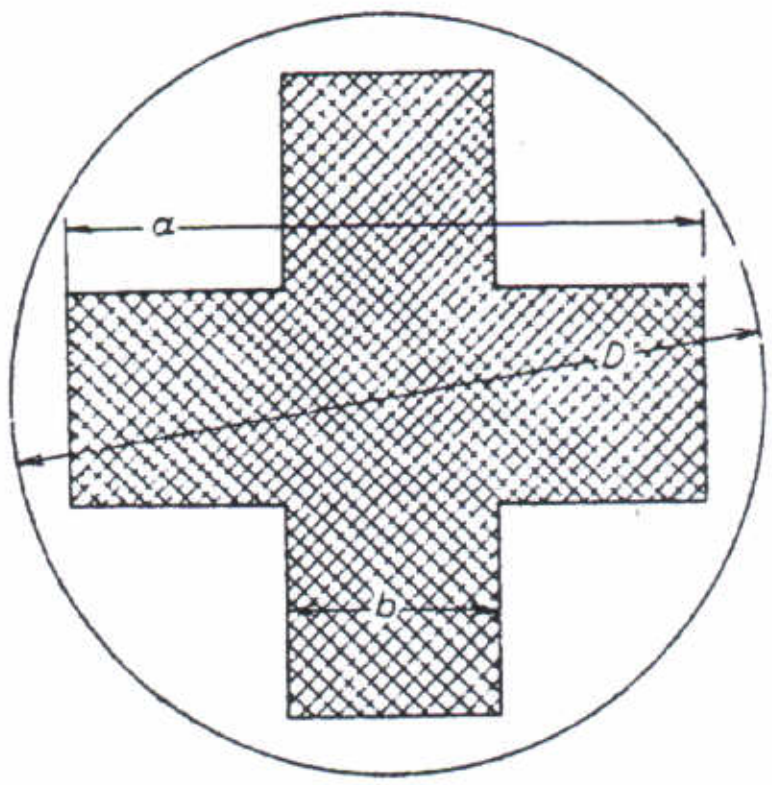
4. Clearcote JS 238 must be sprayed twice in saturation in criss-cross pattern over the coating applied as in step 3, as far as aircraft are concerned which bear this lacquer in accordance with the Surface Protection List or which are used for night operations. Particular care must be taken that the transitional areas between the new coat and the old are sprayed properly smooth.

5. The exhaust trails will be carefully cleaned at all times to prevent excessive soot production and consequent blackening of these areas. This is especially important before daytime use.

Instructions for marking ambulance aircraft

Ambulance aircraft will be marked as follows with immediate effect:

359:



1. Aircraft will receive the camouflage provided for the type.

2. The national insignia (swastika) will be placed on the rudder section as for combat aircraft.

3. A red cross in a white circle will be applied instead of the Balkenkreuz on the wings and fuselage. The ratio of the circle diameter (D) to the length of the bars (a) of the red cross is bar width (b) = D:A:B = 7:6:2. Only the following dimensions will be used:

D =	52	70	87	105	122	140	157	175	192	210
a =	45	60	75	90	105	120	135	150	165	180
b =	15	20	25	30	35	40	45	50	55	60

All dimensions are shown in cm.

The diameter of the white circle will be so adopted using the above dimensions that it covers the Balkenkreuz (on combat aircraft). The red cross will then be applied. Marking colour as per L.Dv 521/1.

Viscosity gauge 3 mm Ø

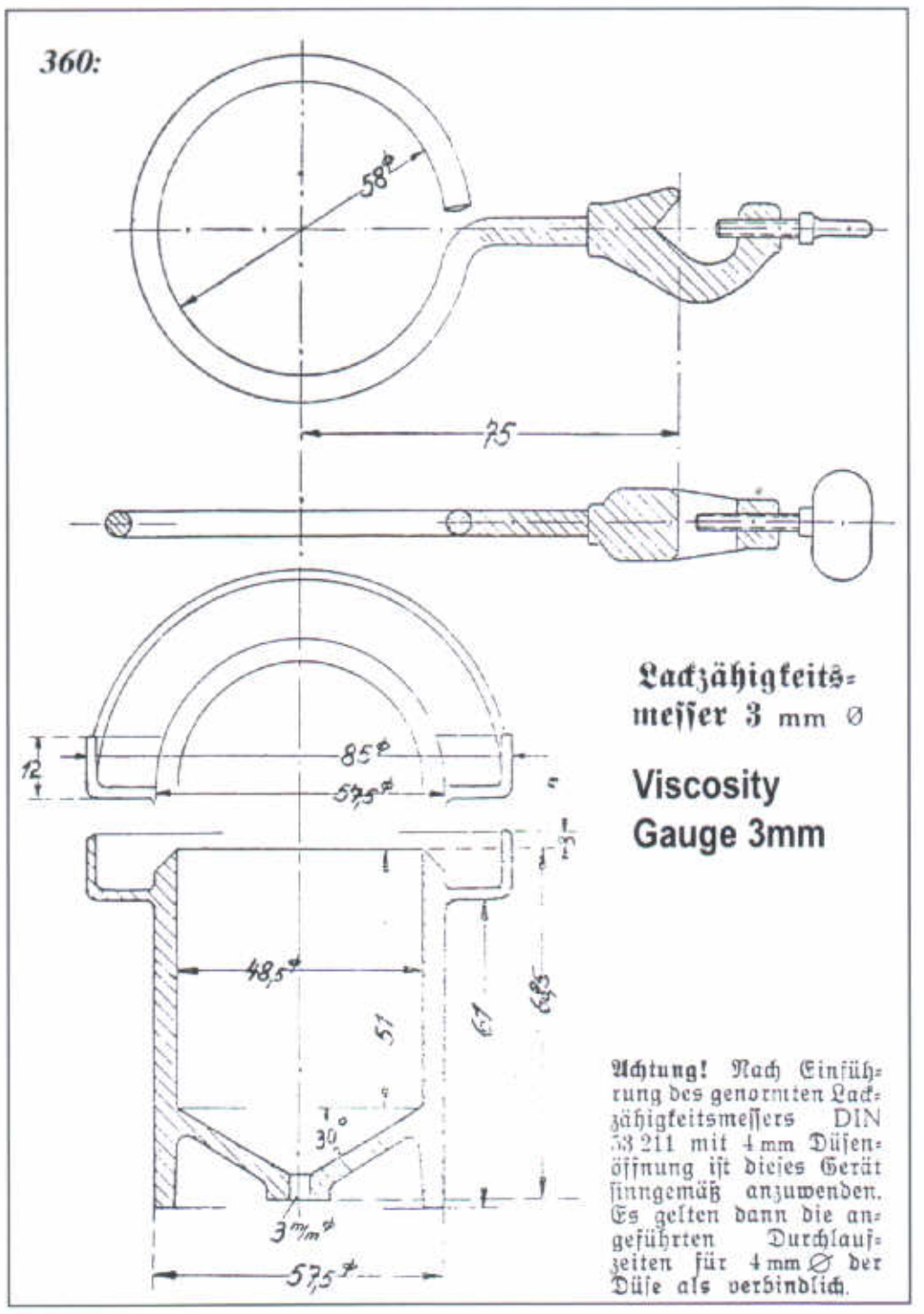
Instructions for use:

The appliance is fastened to a stand or in any other suitable position using the mountings supplied. Care should be taken before measurements are made that the outlet, in particular, is entirely clean.

When taking measurements, the outlet is first closed with a finger of the left hand. The paint to be measured is poured into the beaker until it flows over the edge. When it has stopped flowing over the edge, the outlet is opened by removing the finger and a stopwatch is started at the same time. The procedure ends when the outward flow ceases. The number of seconds required for the paint to flow out indicates the viscosity.

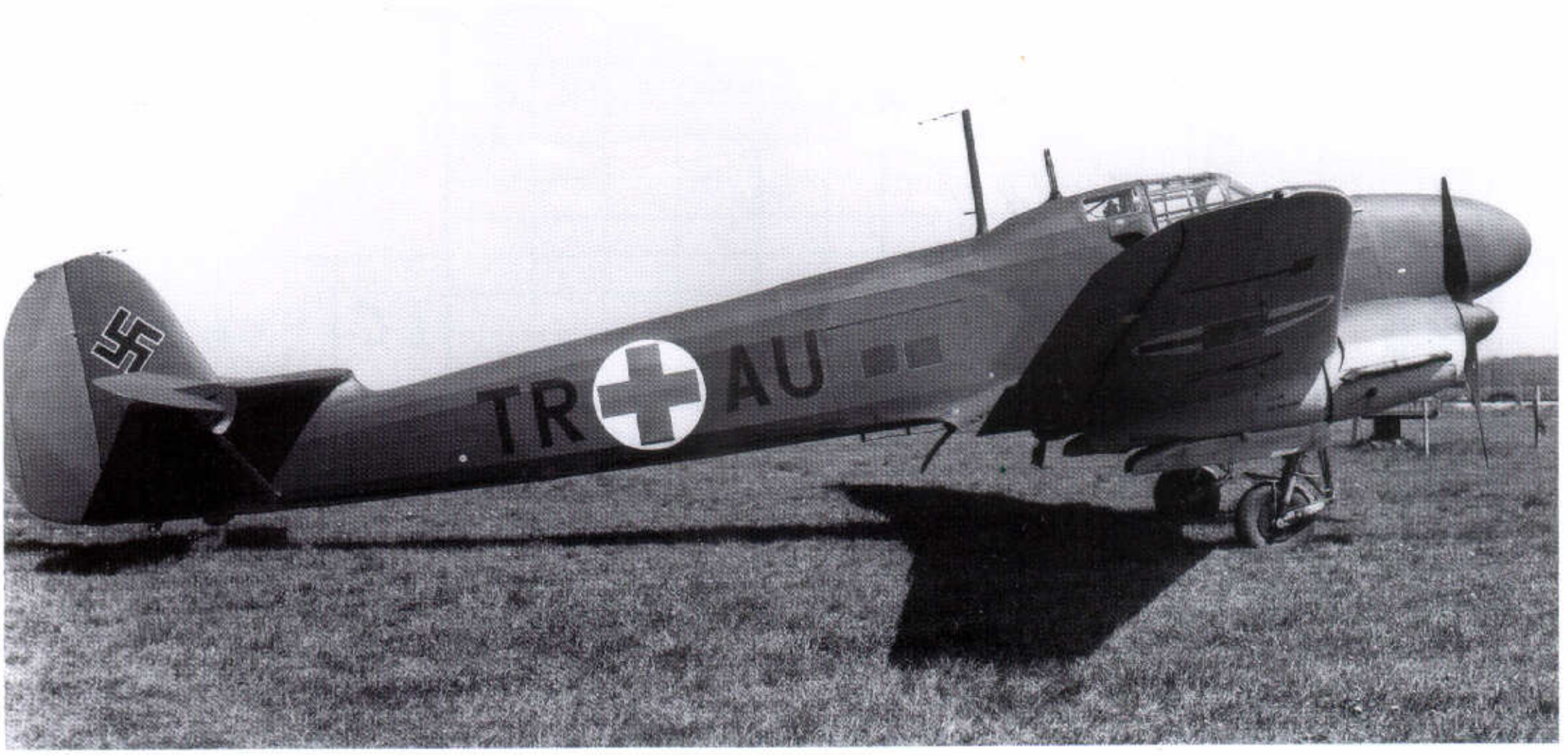
The accuracy of the measurement depends on the temperature, which must be between 18° and 21° C.

Please note! Following the introduction of the standardised viscosity gauge DIN 53 211 with 4 mm nozzle, this device must be used accordingly. The pouring times for the 4 mm Ø nozzle will then be binding.



361 Below: *Another view of the same Focke-Wulf Fw 58G-1 ambulance aircraft, TR+AU, seen earlier in photo 312. The 70/71 splinter camouflage pattern is clearly visible*

362 and 363 Overleaf: *Specimen pages from the Oberflächenschutz Liste (OS-Liste) for the Focke-Wulf Fw 200C*



RLM-Lackierungsformblatt (OS-Liste)* mit Mustereintragungen

	Lfd Nr	Vorkommen: Gegenstand	Vorkommen: aus	Oberflächenschutz: Gruppe	Oberflächenschutz: Flieglackkette bzw Flieglack	Oberflächenschutz: Schichtenzahl innenliegend	Oberflächenschutz: Schichtenzahl außenliegend	Bemerkung
Spalte	1	2	3	4	5	6	7	8
Rh 101	1	Rumpf und Steuerwerk						
02		Rumpfschale, inn.	Duralplat	D	7122.02	1	-	
		aussen	Duralplat	D	7122.65	-	1	Sichtschutz
03					7122.72	-	1	
					7122.73	-	1	
04					JS 238	-	1	Fa. Ruth, Hamburg
05		Profile	Duralplat	D	7122.02	1	-	
		Beschläge, Spante	Stahl u.	D	7102	1	-	Rohre mit 7102
06		Kleinteile, Rohre	Elektron		7122.02	1	-	ausgiessen
07			Dural	D	7122.02	1	-	
		Führerraum	Stahl u.	D	7102	1	-	
08		Gerätebrett	Elektron		7122.66	1	-	
09			Dural + Duralplat	D	7122.66	1	-	
110		Akkulagerung		D	nach LDv 521/1			
11		Dichtungen						
		Behälter						
12		Rohrleitungen (s.Anmerkung 10)						
13		Bugkappe	Holz m. Stoff	D	-		-	siehe Anmerkung 2 u. 9
14		Rumpfheck, innen	Duralplat	D	7102	1	-	
15					7122.02	1	-	
		aussen	Elektron		7102	-	1	
16								
					7122.65	-	1	Sichtschutz
17					7122.72	-	1	
					7122.73	-	1	
18					JS 238			Fa. Ruth, Hamburg
19		Heizung	Elektron	D	Frico-Bronze	1	-	Friedhauer & Co. Asperg (Württbg.)
120								
21								

Änderungszustand der Liste

Änd.	Reihe Nr	Spalte Nr	Tag u. Name	gen	Änd.	Reihe Nr	Spalte Nr	Tag u. Name	gen.

Focke-Wulf Flugzeugbau G.m.b.H. Bremen

LC-E 2 VII C

2.8.41 gez. Unterschrift

	Tag	Name
Entworfen	28.5.	Göringen
Geprüft		
Nachgepr.		

Oberflächenschutz-Liste

FU Fw 200 C-1-2-3 C-3/U-4

Os-Liste Nr: Fw 200 C-1-2-3 C-3/U-4

Blatt Nr: 1

Diese Liste besteht aus ... Blatt

Arbeits-pause Nr

Vervielfältigungs-pause Nr

Vordruck 335

Spalte	Lfd. Nr	Vorkommen: Gegenstand	Vorkommen: aus	Oberflächenschutz: Gruppe	Oberflächenschutz: Flieglackkette bzw. Flieglack	Oberflächenschutz: Schichtenzahl innenliegend	Oberflächenschutz: Schichtenzahl außenliegend	Bemerkung
	1	2	3	4	5	6	7	8
Rh. 01		Lüftung	Elektron	D	7102	1	-	
					7122.02	1	-	
02		Hoheitsabzeichen		D	nach			
03		u. Beschriftung			LDv 521/1			
		Holzteile im						
04		Flugzeuginnern						
05								
06	2	Fahrwerk, Sporn						
		Guss- und	Stahl u.	D	7102	1	-	Siehe bes. Anweis.
		Pressteile	Elektron		7122.02			über Oberflächen-
07								schutz von Stahl.
		Rohre	Stahl	D	7102	1	-	Stahlrohre mit
08					7122.02	1	-	7102 ausgiessen
09								
10	3	Trag- u. Leitwerk						
		Gesamte	Stahl u.	D	7102			s. bes. Anweis. über
11		Tragkonstruktion	Elektron		7122.02	1	-	Oberfl. Schutz von
		nur	als Beispiel					Stahl
12			Dural	D	7122.02	1	-	
13		Beplankung inn.	Elektron	D	7102	1	-	
					7122.02	1	-	
14			Dural	D	7122.02	1	-	
		auss.	Elektron	D	7102	-	1	
15					7122.65	-	1	Sichtschutz
16					7122.72	-	1	
					7122.73	-	1	
17					JS 238	-	1	Fa. Ruth, Hamburg
			Dural	D	7122.65	-	1	Sichtschutz
18					7122.72	-	1	
					7122.73	-	1	
19					JS 238	-	1	Fa. Ruth, Hamburg
20		Bespannung	DIN-Leinen	D	Lackkette 20			
21	4	Triebwerk						
		Triebwerks-	Stahl	D	7102	1	-	siehe bes. Anweis.
22		gerüst			7122.02	1	-	üb. Oberfl. Schutz
								von Stahl
23								
		Brandschott	Duralplat	D	7122.02	1	-	Nicht auf
24								Triebwerksseite
25								
26								
27								
28								
29								

Arbeitspause Nr

Vermietfälligungspause Nr

Änderungszustand der Liste	Oberflächenschutz-Liste zu Fw 200 C-1-2-3 C-3/U-4	Os-Liste Nr Fs 200 C-1-2-3 C-3/U-4	Blatt Nr 2

Vordruck 336

LDv 521/2

Handling and Application Instructions for Aircraft Paints 1943

Part 2: Gliders

March 1943

The Reich Minister of Aviation
and Commander-in-Chief of the Luftwaffe
Engineering Office GL/C No. 280740/42 (E 2 VIII)
I hereby approve the issue of L.Dv 521/2

Berlin, 24 March 1943

"Handling and Application Instructions for Aviation Lacquers"
Part 2: Gliders, March 1943 Edition
Takes effect on the date of publication.
The operating instructions
The Lacquering of Gliders in accordance with the RLM Instructions
are withdrawn as from the same date.

pp.
Vorwald

Introduction

The importance of the glider as part of pre-military training and for ensuring the next generation of pilots gave the RLM the idea of proceeding with the development and creation of the necessary training equipment. Such equipment can be produced and maintained only by simplifying the materials and procedures adopted. The RLM has, with this in view, decided on and licensed the paint systems for gliders. The necessary materials are available from a series of firms under the same designations. The supplier will be allocated to the user units separately by RLM, GL/C-B 2 V.

Reference will be made for this purpose to TAGL Reference I P 10 g No. 32/42, order No. 224/42 of 31.3.42 of the Reich Minister of Aviation and Commander-in-Chief of the Luftwaffe Engineering Office GL/C-TT.

The general particulars in L.Dv 521/1 Part 1: Engine - Aircraft November 1941 Edition will also apply.

Painting gliders

The Construction Rules for Gliders (BVS) of the Reich Aviation Ministry, Issue 3, Airframe, distinguishes between 4 stress groups for sailplanes:

Group 1	Low stress
Group 2	High stress
Group 3	Very high stress
Group 4	All sailplanes not classified under Groups 1 to 3.

The construction materials for gliders consist mainly of wood and fabric. As protection against the weather, all structural parts must be carefully painted internally and externally. Sailplanes are classified as follows for the painting work they require:

Gliders	for beginners - training (Group 1)
Sailplanes	for practice and performance flying (Group 2)
	for aerobatics (Group 3 and where applicable, Group 4)

According to these definitions,
Gliders are painted neutral
Sailplanes in colour (with exceptions)* see Chapter B2.
The work required is described below according to the materials and broken down into interior and exterior paintwork. Notes in the text refer to the BVS application instructions where applicable.

Wood
(BVS Issue 2, Materials, Part II, D2192/b 2; Issue 3, Airframe, Part III, A III b 3227)

1. Interior
All wooden parts such as load-bearing spars, ribs, stiffening, etc. will be painted on the inside. This will be done with a transparent, coloured material. The colour is intended to show whether the interior paint has reached all parts of the internal construction.

Aviation lacquer 7171.99*
will be used (existing stocks of aviation lacquer 7171.27 must be fully used up).

* The two digits behind the point of the four-digit lacquer number in L.Dv 521/1 describe the shade. They correspond to the RLM colour chart. Neutral material is designated as ..... 00. The number 99 (RLM shade 99) ... means that the actual shade or its precise colour is unimportant.

The coat is applied unthinned with a brush. In some cases, e.g. with box spars closed on all sides, parts of the control surfaces, etc. plywood panels forming part of the sheeting must be painted on the inside before assembly. Glued surfaces must be indicated beforehand and must imperatively remain free of paint. After gluing, the parts not previously painted must—if accessible—be carefully coated with the prescribed lacquer (see BVS Issue 2, Materials, Part II, C III 2160 and D II, 2193/2194).

Drying time: 2 hours.

These and all the following drying times apply at an average ambient temperature of approx. 20 C and are indicative.

2. Exterior
(BVS Issue 2, Materials, Part II, D II 2193-2198)

Weather can have a particularly drastic effect. While interior painting is intended merely as protection against damp air and condensate, the exterior lacquering must stand up not only to strong temperature fluctuations but also to the ravages of sun, rain and biting wind as well as mechanical wear and tear. Assembly must therefore be undertaken carefully and conscientiously, the prescribed drying times being carefully observed for each individual layer. Exterior painting entails plywood and impregnated fabric (see Chapter II).

Neutral paints
Both the wooden parts and the fabric of gliders are painted neutral. See II B Fabric for doping.

The clean, smooth wooden surfaces are treated as follows:

1. Priming with aviation lacquer 7171.00:
   The primer is supplied ready for use. It is applied with a brush. As the material dries relatively quickly, the complete brush must be used smoothly in the direction of the fibre. Areas of approximately 1/4 m2 only are prepared for this purpose in each case and uniformly painted.
   Drying time: 2 hours.

2. Undercoating with aviation lacquer 7175.00:
   The material is ready for use. It may be thinned with a little
   aviation thinner 7211.00
   Especially for spraying. Apply thinly!
   Drying time: touch dry in one hour,
   non-sticky in 3 hours.
   Cured overnight.

3. Final coat:
   After the first lacquer coat (see step 2) is fully cured (after 16 hours, i.e. over night), a further coat of
   aviation lacquer 7175.00
   is applied. If a particular smooth surface is to be achieved, the first lacquer coat will be ground in lightly with water and emery paper No. 320 before the topcoat is applied.

Note: Don't over-sand!

The lacquer must be left alone for at least 6 hours, over night if possible, after sanding, so that the surface opened up can harden again. If paint is applied too early, the still wet undercoat will be drawn out.

Coloured wood paints
(To be used on all sailplanes - not for gliders)

The wood is carefully dusted and subsequently treated as follows:

1. Prime with aviation lacquer 7171.00
   (See item 2.a.1)
2. Work up with glider putty 7251.99.
   The material is supplied ready for use. The scarfing on the skinning, minor errors in the plywood surface and holes in the nailed frames are stopped with undiluted filler. The filler may never be thickly applied since the filled areas will otherwise crack. Larger hollows will be smoothed down by repeated soaking. The drying times between applications must be carefully observed.
   Drying time: 6 hours.
   If necessary, the pores in the plywood are lightly scraped with some thinned scraping filler to achieve a particularly smooth surface for the paintwork on final painting. The filler will be made more pliable for this purpose by adding a few percentage points of aviation thinner 7211.00. When stopping, the material applied must immediately be scraped from the surface with an oblique knife blade under pressure, at right angles to the direction of the fibres so that only the pores remain filled and all surplus filler is removed from the surface.
   Drying time for the thin filled areas also: 6 hours.
3. Sand dry with emery papers 180-200. After sanding, the area must be carefully dusted.
4. Undercoat with aviation lacquer 7172.99:
   The material is supplied ready for use. It may be applied either with a brush or with a spray gun. Where necessary, especially when spraying, it may be thinned with approx. 5-10% aviation thinner 7211.00. Generally speaking, the material must

be slightly more fluid for spray purposes than for painting. Spraying will ensure a better surface, using less material.
Drying time: 6 hours.

5. Sand dry with emergy paper No. 220-240. Dust down carefully.
   Dust down, don't sand through.
6. Lacquering with ivory shade aviation lacquer 7174.05:
   The lacquer is supplied ready for use. If necessary, especially for spraying, it may be thinned with approx. 10% aviation thinner 7211.00. It is applied with the spray gun in such a way that the surfaces are first very thinly misted for subsequent uniform lacquering, but not too thickly.
   Drying time: touch dry in 2 hours.
   Cured overnight.
   Where surface smoothness is subject to particularly heavy stress, a further coating of aviation lacquer 7174.05 may be applied. The procedure is then as follows.
7. After curing, the surface is rubbed down with emery papers 280-320 and water. After sanding, the surface is leathered down well and must then be left alone for at least six hours so that the opened up surface can harden overall.
8. Paint with Ivory shade aviation lacquer 7174.05
   Drying time: touch dry in 2 hours.
   Cured overnight.

NB: For technical reasons, the coloured topcoat of aviation lacquer 7174.05 is applied to the wood and stretched fabric in one go.

Cockpit painting

The plywood sheeting and ribs of the cockpit will be pre-treated with transparent aviation lacquer 7171.99 in accordance with A (1).

1. Rub down slightly when dry, remove all dust.
2. Pre-paint with aviation lacquer 7172.99.
3. Topcoat of aviation lacquer 7174.02.

Fabric

Apart from general protection, painting the fabric with dope is intended to tension the material.

1) Dope
(applicable to gliders and sailplanes)
(BVS Issue 2, Materials, Part V, B III, 2440 to 2444, Issue 3, Airframe, Part III B Vb. 3410).

i. Undercoat with aviation lacquer 7173.00:
   The lacquer is applied unthinned and brushed on sufficiently smoothly for the fabric to be wetted throughout on initial painting and becomes visible in bare patches on the reverse. Only then will the correct tension be achieved.
ii. Sticking on the masking tapes:
   The masking tapes, which are intended to cover the seams, are stuck down immediately after initial doping.
   Aviation adhesive 7252.00
   is used for this purpose. The tapes are stuck down in such a way that the seam to be covered is filled with adhesive. The tape is then applied cleanly immediately afterwards, by two persons from the centre if possible. A single coating of dope is applied to the tape immediately after it is laid down, using
   Aviation lacquer 7173.00.
   Drying time: 2 hours.
ii. Undercoat of aviation lacquer 7173.00:
   Paint normally, i.e. not as fully as for the first coat.
   Drying time: 2 hours.
iv. Rubbing down.
   Grind lightly dry. The fabric may not be damaged, especially at the edges. Dust down well.
v. Topcoat with
   aviation lacquer 7173.00
   Paint normally, i.e. not too thickly.
   Drying time: 2 hours.
   The number of applications of dope may be increased by one depending on the type of fabric and its properties. In this case, the third coating and not the second must be rubbed down as the penultimate coat. The last coat is not sanded down.

2) Topcoat
(for sailplanes only)
(BVS Issue 3, Airframe, Part III, A III b. 3235).
The fabric after doping is complete and dried throughout is coated over once only with
Aviation lacquer 7174.05 (or 7175.00*)
(see II A 2 b 6 and Note).

* A pigmented finish with aviation lacquers for sailplane use is intended as the topcoat for fabric. This is not possible in every case as the centre of gravity may be displaced. For necessary weight saving on account of centre of gravity displacement and the associated difficulties in handing over, aviation lacquer 7175.00 may be used (e.g. Kranich 2). Consent must in all cases be obtained from RLM - GL/C-E 2 V.

Metal

(BVS Issue 3, Airframe, Part III A III b. 3230)
Metal parts that are chemically pre-treated (e.g. galvanising of steel, anodising of Dural) must be painted immediately after drying. Metal parts not chemically pre-treated must be carefully degreased with a cleaning agent approved by the RLM before painting.

Metal parts, whether chemically pre-treated or degreased will be painted as follows:

1. Priming with aviation lacquer 7102.99:
   (BVS Issue 2, Materials, Part III B IV 2240 - 2241 - Part IV D 2393 to 2396)

Drying time: 4 hours.
Pipes must be filled with this aviation lacquer 7102.99 and then allowed to run out. The thinner for this aviation lacquer is 7200.00.

2. Parts exposed to the free air flow will additionally be coated with
aviation lacquer 7174.05
or, in the cockpit, with
aviation lacquer 7174.02
(see II A 2 b 4).

National insignia and lettering

The prescribed drying time of at least 15 hours for the last topcoat must be carefully observed before the national insignia are applied. The following lacquers may be used for lettering and for applying national insignia:

aviation lacquer 7164.21 (white),
aviation lacquer 7164.22 (black),
aviation lacquer 7164.2 (red).

These aviation lacquers may be processed only by brushing. Thinning is unnecessary. Thinning is permitted with

aviation thinner 7211.00

only if the paint has subsequently thickened.
Drying time: 3 hours.
Transfers may be used instead of lettering etc.

Lacquer repairs for sailplanes

The lacquering on an aircraft provides surface protection for the construction material on which airworthiness depends. All damage—even of the most minor kind—must consequently be immediately repaired without exception.

As with new painting, work will be carried out differently according to whether the parts to be repaired are made of wood or fabric.

Lacquer repairs on wood

Repairs to interior paintwork.
Internal structural parts which require improving are treated as new for painting purposes, i.e.
brushing with

aviation lacquer 7171.99 (see II A 1).

Repairs to exterior paintwork.
Wooden parts of the aircraft, such as e.g. sheeting etc., which require replacing are treated precisely as laid down for the painting of new sailplanes. The surrounding paintwork will be worked up as follows before the parts to be renewed are inserted.

1. Cleaning:
The old lacquering is carefully washed down and degreased in a broad area around the damage, at least as wide as will subsequently be covered with paint, using a cleaning agent approved by the RLM.

2. Degreasing old paintwork:
The old lacquering will be removed with a stripping knife from the edge of the damage to such an extent that approximately a hand's breadth of the wooden substrate is exposed*.
* Care should be taken when treating wood with strippers. Stripper tends to be absorbed by the pores in the wood, where it remains.
Wooden parts containing stripper in their pores, even in dry form, are difficult to paint. Either, the paint adheres imperfectly, or it refuses to dry.

3. Rubbing down the edges:
The edges of all paintwork must be sanded down clean and dry using emery paper No. 220 and 280, so that no sharp edges can be felt. Dust down carefully.

4. Replaced wooden parts and the exposed wooden sheeting are sealed and subsequently worked up as under II A. 2 a or b.

Lacquer repairs on fabric

a) Damage to fabric and paintwork:
In principle, all tears in the fabric must be sewn.

1. Stripping:
The paintwork in a circle round the damaged area is saturated with

aviation stripper 7210.99.

After allowing a few minutes for absorption, the colour will peel. Older lacquering must if necessary be coated a second time with stripper. The peeled off colour is removed with a blunt wooden or horn knife and soft rags.

2. Cleaning:
The stripped area of the fabric and its immediate environment are then washed down with a cleaning agent approved by the RLM.
Note carefully: make sure that neither stripper nor cleaning agent penetrates the interior of the aircraft through the tear in the fabric, so that parts of the paintwork or fabric underneath might be damaged.

3. Softening up of the dope:
The fabric will be wetted with wadding or a rag in a circle round the damaged area using

aviation thinner 7211.00,

so that the dope on the fabric begins to peel off.

4. Adhesion:
The section of fabric cut to size and intended to be stuck on the tear is now dipped in

aviation lacquer 7173.00.

The lacquer is spread lightly and the patch is

placed quickly on the area to be repaired. Care must be taken that the thinner painted on to soften the old dope has not yet evaporated. The patch to be stuck on must therefore be placed on the still wet repaired area to ensure good adhesion.
Drying time: 1 hour.

5. Lacquering:
Finish in accordance with II B 1, 3, 4 and 5, with a topcoat if necessary according to II, B 2.

b) Damage to the paintwork.
Provided the paintwork is undamaged, stripping may be begun (item 1), the area then cleaned (item 2) and a finish applied in accordance with Instruction II B 2.

Lacquer repairs to metal parts
When repairing the paintwork on metal parts, particular care must be taken that the parts to be painted are entirely free of grease. In addition, the type of processing will depend on whether the metal substrate is bare. If it is not so, no repeat priming is necessary when adding new paint.
If the metal is bare, the procedure is as follows, depending on the extent of the damage:

1) Minor damage to paintwork.
a. Cleaning:
Removing all loose parts of the paint with a putty knife or a wire brush and cleaning with a cleaning agent approved by the RLM.

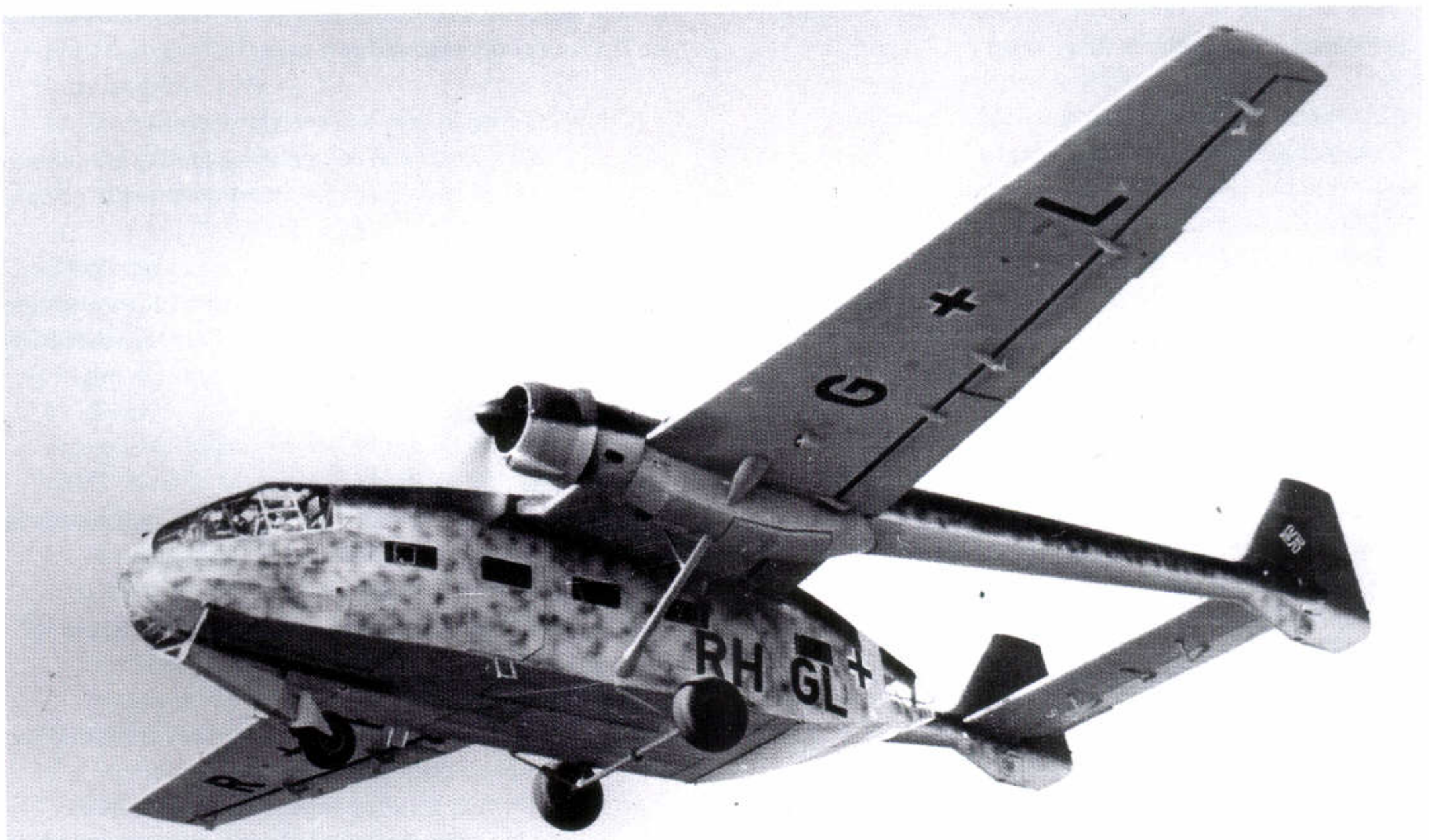
b. Priming with aviation lacquer 7102.99:
But only at the spots where the metal shows through. A brush will necessarily be used for making repairs.
Otherwise, see II C. 1 and 2.

2) Major damage to paintwork
a. Strip:
The old paint is saturated with
aviation stripper 7210.99.
After a few minutes, the softened paint is flaked off with a blunt horn or wooden knife and rubbed down with a rag.
If the paint has not yet been entirely removed, the procedure is repeated once more at these points.

b. Cleaning:
Washing down of parts with
aviation cleaning agent Z
The parts are thoroughly coated with aviation cleaning agent Z with a brush or rag when wet and subsequently wiped down dry with a clean rag.

c. Priming:
The thoroughly cleaned metal part is primed with
aviation lacquer 7102.99
and otherwise treated further as for II C. 1 and 2.

364 Below: *Although fitted with engines, the Gotha Go 244B-1 was regarded as being akin to a powered glider. As the Go 244 flew in 1942, it is in 70/71/65, the 81/82 shades designed specifically for glider use not appearing until late in 1943. This particular machine has yellow wing tips and fuselage band*



LDv 521/3

Draft Specification of Handling and Application Instructions for Aircraft Paints 1938

1937 Edition
With Amendments 1-3

The Reich Minister for Aviation.
Commander-in-Chief of the Luftwaffe

Berlin, 22 March 1938

p.p.
Graf Baudissin

General

Definition: Improving.
Improving for present purposes means removing damage occurring over a limited area to aircraft paintwork. The painting of entire aircraft or only their exteriors or the painting of entire aircraft components such as e.g. wings, fuselage, control surfaces, etc. is called repainting. The following Instruction refers only to improvements. Repainting is covered by L.Dv 521/1.

2) When improving should be undertaken
The airworthiness of an aircraft depends on the properties of its materials. Every effort must therefore be made to ensure that the protection of aircraft surfaces is faultless. Damage to the surface protection must be eliminated as soon as it occurs. The result of leaving aircraft to stand for weeks with paint damage, especially in the open, is their premature unserviceability.

Principle: paint damage must be made good immediately it occurs!

Rules for improving lacquered aircraft surfaces

1) All-metal aircraft and metal parts, general

a. Damage of minor extent or bare patches up to about a hand's breadth in size must first be care fully cleaned with aviation cleaning agent Z, using clean rags. The edges of the paintwork will be smoothed. The cleaned area will then be painted up with

aviation lacquer 7122.-,
or for naval aircraft, with
aviation lacquer 7102.-.

After a drying period of 6 hours, naval aircraft will be worked on further in accordance with L.Dv 521/1 (see Application Instructions for lacquer groups 02 and 04). Damage to metal joints and rivet sets will be dealt with as follows. Soil and loose paint residues will be carefully removed from the rivet sets. This will be done with compressed air or steel wool 00 depending on the degree of soiling, care being taken that the metal is not harmed. It is then washed down with aviation cleaning agent Z. The paint edges will be smooth. After painting with

aviation lacquer 7122.-,
or for naval aircraft,
aviation lacquer 7102.-

and 6 hours' drying time, open joints must be sealed with aviation sealant 7240 or 7241. See L.Dv 521/1 for further working (Application Instruction for lacquer group 02 and 04).

b. Major damage to paintwork, exterior.
On extensive damage to paintwork, paint remaining on the metal sheeting will be removed with aviation stripper 7210.00. Care will be taken at all times that all openings permitting access to the interior of the components concerned are covered beforehand. After residual paint is removed, the surface is thoroughly washed down with aviation cleaning agent Z, especially at rivet sets and metal joints. After the cleaning agent has evaporated,

aviation lacquer 7122.-
is sprayed in standard finish, or

aviation lacquer 7102.-
for naval aircraft.

Naval aircraft are dealt with further in accordance with L.Dv 521/1 (Application instruction for lacquer groups 02 and 04)

c. Paint damage to the aircraft interior.
Aviation lacquer 7112.02 is used to make good minor damage to the interior paintwork of land aircraft.
Areas of major damage will be sprayed with lac-

quer 7122.02. The interior of naval aircraft will be preserved in precisely the same way as indicated in II 1a and b.

Anodised metal parts (surface protection group C) must not be painted. If the operator has not yet replaced such parts with the anodised equivalent, the new parts must be painted with aviation lacquer 7122.02 or, for naval aircraft in accordance with L.Dv 521/1, lacquer group 02 and 04.

Please note: always use respirators when undertaking extensive painting work inside an aircraft.

Composite aircraft

a) Metal parts
To be treated as indicated in II 1.

b) Wooden parts

1. Wooden parts not exposed to the free air flow.
Parts to be repaired must be carefully stripped with a stripping knife and the edges then round the pre-treated area rubbed down with emery paper and the dust brushed off. The parts to be repaired must then be painted with three coats of aviation lacquer 7140.- thinned in accordance with L.Dv 521/1 with aviation thinner 7233.00 observing a drying time of 3 hours in each case. Replaced wooden parts, i.e. those newly produced, which have not yet been painted must be treated with aviation lacquer 7140.- in accordance with the appropriate application instructions in L.Dv 521/1. Larger areas must be sprayed.

2. Wooden parts exposed to the free air flow ("exterior")
Damaged parts must be saturated with aviation stripper 7210.00 using a brush. After an absorption period of approx. 10 minutes, the dissolved paint must be removed with a blunt wooden or horn knife or with a rag. This process must be repeated until the wooden surface shows clean.

The edges of the areas from which paint has been removed will be carefully rubbed down with sand paper. The dust forming must be carefully removed. If the aircraft concerned is to be painted in colour, lacquer group 30 is then applied. Lacquer group 31 will be used for silver aircraft (L.Dv 521/1). A painted wooden component will be only lightly coated with aviation lacquer 7130.00 thinned 2:1 with aviation thinner 7230.00 after stripping.

c) Improving the doping of fabrics.
Principle: Since the raw material for fabric (linen or cotton) is largely of foreign origin, the leathering of aircraft must in all cases be restricted to necessary instances where airworthiness must be maintained. Leathered fabric—even smaller pieces—must be stored in dry, well-ventilated rooms until required for stripping.

1. If paintwork and fabric are damaged.
Tears, including those of minor extent, must be sewn up in all cases. The paint film in the area around damaged spots will be softened with aviation thinner 7230.00, the thinner being applied with wadding or a soft rag.
A section of fabric cut to size and intended for covering the tear must now be dipped in aviation lacquer 7130.-, the lacquer lightly wiped down and the patch stuck to it without first permitting the thinner to evaporate from the repaired area. After a brief drying period, the patch will be painted once only with aviation lacquer 7130.00. This process must be repeated after a drying time of one hour.
In urgent cases, the aircraft can already start up after a further one hour's drying time and painting completed later. In other cases, work will continue after one hour's drying time in accordance with L.Dv 521/1 (see Application Instruction for lacquer groups 20 and 21).

2. If only the paintwork is damaged (fabric is unharmed)
The damaged paint—cracked or brittle—will be saturated in the immediate neighbourhood of the damaged area with

aviation stripper 7210.00.

The coating will be removed—possibly after repeated application of stripper—using a blunt wooden or horn knife and soft rag, until the exposed fabric still displays only a light red-brown colour.
When paint removal is complete and after light biting and smoothing of the painted edges, work will continue in accordance with L.Dv 521/1 (see Application instruction for lacquer groups 20 and 21).

3. When opening the fabric to gain access to structural parts inside, every effort will be made to spare the fabric as far as possible so it can be re-used.

General

a) In cases not specially mentioned in this Instruction, proceed in accordance with L.Dv 521/1*.

* As far as (a) is concerned, this also applies to the use of special paints as for instrument panels, battery mountings, airscrews, the insulation of painted metal and wood in contact with dopes, etc.

b) When repairing damaged structural parts made of welded steel tubing (e.g. fuselage), the steel tubes will be painted internally (L.Dv 521/1 Part C, Section 4, paragraph B) but only insofar as technically feasible.

c) Aircraft painted in non-flammable lacquers under L.Dv 521/1, e.g. Ar 196, Bü 131, certain He 60s and the like, may not be improved with normal aviation lacquer since this is incompatible with non-flammable lacquers. The aircraft concerned will either be designated as "painted non-flammable" or an appropriate entry will be made in the aircraft log.
The following lacquer groups under L.Dv 521/1 are appropriate for improvements:

Metals:	Lacquer group 05
Fabric:	Lacquer group 22
Wood:	Lacquer group 33
Thinners:	Aviation thinners 7213 and 7215.

Rules for applying camouflage to metal propeller blades and spinners

Properties of the metal surface

The surfaces of new propeller blades may not be polished. The original paintwork on repaired airscrews or hoods must be completely removed on both sides.
It will be removed with aviation stripper 7210.00. The stripper is brushed twice onto the old coating for this purpose. The coating is removed with wood wool after it has become completely soft.
The surface of parts from which paint has been removed or which are supplied bare must be thoroughly degreased and cleaned with aviation cleaning agent Z. Priming must start immediately after cleaning to prevent soiling and dust settling on the cleaned parts.

Applying camouflage paint

The blades of propellers (suction and pressure sides) and the surface of the spinners must be treated as follows when applying camouflage paint:

a. Aviation lacquer No. 7142
Spray thin
Thinning ratio: 1:1 with aviation thinner 7200.00
Drying time: at least 2 hours.

b. Aviation lacquer No. 7146.71
Spray
Thinning ratio: 1:1 with aviation thinner 7200.00
Drying time: 3 hours

c. Aviation lacquer No. 7146.70
Spray
Thinning ratio: 1:1 with aviation thinner 7200.00.

When spraying previously unbalanced propeller blades, care must be taken that a strip 30 mm wide above the edge of the spinner is not sprayed (see Sketch) so that the mark for blade adjustment remains visible.

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This area must be protected with masking tape before spraying. The painted propeller blades and spinners must be rebalanced after a drying time of 3 hours, minor balancing errors being eliminated by further spraying with lacquer. Propeller blade and spinners are ready for operation after a further 12 hours. Propeller blades and spinners may not be greased.

Paint testing

Throughput time in the viscosity gauge (Ford beaker)
The lacquer thinned ready for spraying displays the following pouring times at 20°C:
aviation lacquer No. 7142.00 85-95 s
aviation lacquer No. 7146.70 and 7145-55 s.

Storage and despatch

Lacquers should always be stored in areas where the temperature is at least +8C. They are despatched in canisters holding 5, 10 and 25 kg.

Manufacturers

See L.Dv 521/1 for a list of suppliers and a paints overview.

SAMMELMITTEILUNG 1

Sammelmitteilung 1 [Collective Communication 1] is reproduced in its entirety below:

The Reich Minister for Aviation
and Commander-in-Chief of the Luftwaffe
Technical Office
No. 237/44 (GL/C-10 IV E) Ref. 70 K 10

Berlin W8, 1 July 1944
Leipziger Stra§e 7
Tel.: 218011
Ext.: 3208

F.A.O. all aircraft manufacturers, licensed producers and repair shops, and their production managements

Re.: Introduction of new aircraft paints/varnishes and surface protection procedures, reports, camouflage.

Adhesive Varnish for:

Adhering Fabric to Fabric, to Wood, to Metal when used with Normal, Flammable Paints. – Flw. (= aircraft material) 7280.99.

Following extensive trials at the Travemünde Test Centre, the adhesive varnish No. 4637 of Messrs. Atlas AG, Mölkau near Leipzig, which is already currently in use, is being introduced generally under the designation aircraft varnish 7280.99.

Intended use:
Aircraft varnish 7280.99 serves for adhering
fabric to fabric
fabric to wood
fabric to metal.
Field of Application:
Flw. 7280.99 is compatible with all aircraft paints/varnishes used for the normal preservation of metal, wood and fabric; however, it is not suitable for non-flammable aircraft paints (aircraft paint systems 05, 22, 33, Flw. 7141 etc.). These require a special adhesive varnish.

Application instructions:
Flw. 7280.99 is to be mixed as required with paint thinner 7230.00 into a brushable consistency; where larger areas are involved 7230.00 is thinned by 10 to 20%, for spray application the ratio is 1 : 1.
The surfaces to be adhered must be clean, dry and grease-free. Care must be taken that workrooms are sufficiently warm.
The parts to be bonded are precoated (sprayed) with adhesive varnish and after drying (approx. ½ to 1 hour) a second coat is applied. A few minutes after the second coat the parts can be joined. The parts have to be joined while the adhesive varnish is still sticky. If the surface already feels dry, insufficient bonding would result and the surfaces in question have therefore to be recoated with highly diluted adhesive varnish or, where applicable, with aircraft thinner 7230.00.
When adhering to metal it is essential to apply two coats of adhesive varnish, whereby the first coat should preferably be allowed to dry for 1 - 1½ hours. If larger metal surfaces are to be covered with fabric, the first coat should be allowed to dry for several hours, preferably overnight, and the coated fabric placed immediately on to the second coating. The fabric is then thoroughly pressed down and given a final coat of
1 part adhesive varnish 7280.99 mixed with
1 part thinner 7230.00.
The overpainting with aircraft paints can take place after approx. 3 hours.
The suppliers of the varnish are Messrs. Atlas AG, Mölkau near Leipzig, tel. 64001, or their licensees. Allocation of suppliers is via RLM GL/C-RPV.

Adhesive Varnish for:

Adhering Fabric to Metal when using Non-flammable Aircraft Paints (Aircraft Paint Systems 05, 22, 33 etc.) – Flw. 7285.99

For the above purpose the adhesive varnish "WZ 7826 oxide red" of Messrs. Herbig-Haarhaus A.G. 22, Köln-Bickendorf, tel. 58591, is being introduced under the designation:
Aircraft varnish 7285.99.

Intended use:
Aircraft varnish 7285.99 is used for adhering fabric to metal.
Field of application:
Aircraft varnish 7285.99 is intended for use in connection with non-flammable aircraft paints (aircraft paint systems 05, 22, 23 etc.), it is unsuitable for normal aircraft paints (such as e.g. 7121, 7101 etc.).

Weldable Priming Paint for:

Steel and Light Alloys – Flw. 7191.99

Following trials in the aircraft industry, electrical industry, at the Travemünde Test Centre and GL/C-Fertig, the H 3886 weldable paint of Messrs. Dr. Kurt Herberts, Wuppertal-Barmen, Christbusch, is being generally introduced under the designation aircraft paint 7191.99.

Intended use:
Flw. 7191.99 serves as corrosion protection at overlapped locations which are either point or roll-seam welded.

Field of application:
Flw. 7191.99 for use on steel and aluminium. With steel its corrosion protection index is slightly lower than aircraft primer, but quite sufficient between overlaps, as these are not subject to mechanical stresses after welding. Because the paint is softer than the previous aircraft paints, it should, if possible, only be applied at overlapped areas. It is compatible with normal aircraft paints (7101, 7102, 7121).

Application instructions:
Flw. 7191.99 can be brushed on, dipped or sprayed in the condition as supplied. With spraying it may be necessary to add some thinner. Generally only losses due to evaporation need to be replaced.

Thinner Flw. 7200.00

The paint is dust-dry after approx. 10 mins, transport-dry after 30 mins. The painted overlaps may be welded either shortly after drying or after lengthy storage, as the length of drying time does not affect the welding ability.
Supplier: Sole manufacturer Messrs. Kurt Herberts, (22) Wuppertal-Barmen, Christbusch, tel.: 53316

Replacing Flw. 7151.99 by 7152.99.

The aircraft paint 7151.99 used hitherto has exhibited certain faults, which are remedied with the improved paint
Flw. 7152.99.
The introduction of this aircraft paint is to be implemented immediately. Any existing stocks of aircraft paint 7151.99 in excess of 10 kg can be offered as returned stock to the sole manufacturer, Messrs. Herm. Frenkel (IC), Mölkau near Leipzig, tel. 644101.

Discontinuing Ferry Markings

The markings used hitherto, consisting of black or white letters in water-soluble paint on the aircraft fuselage, are discontinued with immediate effect. In their stead the serial number without additions, i.e. only the number itself, is to be painted on both vertical tail surfaces. Shade 22 or 21, aircraft paint 7160 or 7164 or 7165. The height of the numbers is 25 cm, or if necessary—e.g. when infringing on the Balkenkreuz—smaller.

Camouflage for Gliders (not Transport Gliders)

For the duration of the war all gliders and sailplanes are, with immediate effect, to be given a camouflage finish, whereby all parts visible from above or from the side are to be camouflaged until further notice with aircraft paint 7174.81 or 82 after the final work stage according to L.Dv. 521/2.
The camouflage colours are to be applied to the aircraft's upper surfaces and fuselage sides in similar fashion to the splinter finish of powered aircraft. If splinter scheme diagrams have not yet been distributed, they can be requested from the supply depot N.S.F.G Worms/Rhine, airport.
The following new sub-section should be added after section II D of L.Dv. 521/2, page 13: (Cut out and paste in):

Camouflage paint
Until further notice all gliders and sailplanes are to be given a camouflage finish. After the coats listed under A., B., C. are thoroughly dry (approx. 16 hours after the last coat) the camouflage is to be applied with

Aircraft paint 7174.81 or 7174.82

in the splinter finish.
The paint is applied only as thickly as is absolutely necessary for the camouflage effect. The aircraft paints are supplied ready for use. If necessary, particularly when spraying, they may be diluted with

Aircraft paint thinner 7211.00.

Drying time: dust-dry 1 – 2 hours, thoroughly dry overnight.
As an immediate measure, prior to the issue of this regulation, the respraying of those gliders in service was already, and is still being, carried out. During this intermediate period it was permissible to overspray the aircraft with the existing aircraft paint 7135 in shades 70 and 71, as it was impossible to produce and deliver the above paints in the new shades in time.
It should be noted that overspraying with the paints specified could result in changes in weight as well as in the centre of gravity!

Delivery of colour charts for RLM shades 81 and 82 is currently not possible. For this reason there is no acceptance inspection of the paint's shade.

In addition to the above addendum, the following handwritten changes are to be made in L.Dv. 521/2:

Page 12: Section II C 1: Change aircraft paint 7102.99 to "aircraft paint 7101.99".

Page 14: Section III B a) 1: Change aircraft paint remover 7210.99 to "aircraft paint remover 7209.99".

Page 16: Section III C 1.2.): Change aircraft paint 7102.99 to "aircraft paint 7101.99".

Page 16: Section III C 2.1.): Change aircraft paint remover 7210.99 to "aircraft paint remover 7209.99".

Page 16: Section III C 2.3.): Change aircraft paint 7102.99 to "aircraft paint 7101.99".

Existing stocks of Flw. 7102.99 and Flw. 7210.00 are to be used up. However, new orders must be in accordance with the above changes.

Reporting on Non-aircraft Paints in Aircraft Construction

By 15 Aug. 1944 all aircraft factories are to submit a report to GL/C-E 10 IV on all non-aircraft paints used in aircraft construction laid out according to the following example:

Description	Supplier	Used for	Aircraft type	Monthly requirement
Exhaust paint heat-resistant Ikarol 173	Warnecke & B hm Berlin-Weissensee	Exhaust pipe & other heated pipes constructed of ...	He 111	275 kg

The intention is generally to introduce that product which is the most advantageous in terms of raw materials. Only in this way will the necessary control and safeguarding of supplies by GL Ro IV and the Reich Office for Chemicals be possible.

Application of Colour Shades 81 and 82

In the letter GL/C-E 10 No. 10585/43 (IVE), Ref. 82 b 10, of 21.8.43 the future introduction of camouflage shades 81 and 82 to replace 70 and 71 was announced. The introduction of these shades has now been defined as follows:

1) For new aircraft types which, because of their intended employment, would hitherto have been painted with shades 70 and 71, the shades 81 and 82 are to be used.
2) With types currently in series production the changeover from shades 70 and 71 to 81 and 82 is to be implemented at the next convenient point in time. Existing stocks of 70 and 71 should, of course, be used up.

As it is unlikely that both shades are going to be used up at the same time, and in order to avoid small reorders of 70 and 71, it is permissible to use up any residual amounts in the following combination:

Colour shade 70 (as residual amount)
+ colour shade 82
Colour shade 71 (as residual amount)
+ colour shade 81

However, should the remaining amount of one shade simply be too large, and the transition period to the regulation camouflage therefore too long, then attempts must be made to exchange these amounts with subcontractors, industrial works or other aircraft factories.

3) The method in which these new shades are to be applied (splinter finish) remains unchanged.
4) The aircraft factories are to report to GL/C-E 10 IV on the implementation of the colour shade change with the amended OS list [Surface Protection list].

Surface Protection Process ABL 35 for:

Fitted and Threaded Parts made from Flw. 2510

Based on research undertaken by the DVL, surface protection process ABL 35 is being introduced to replace the current boiling process in 5% potassium dichromate solution. No changes in operations are involved apart from the higher boiling temperature of 130° to 135°C. The corrosion protection provided by the ABL 35 process is considerably higher than that of the method used hitherto. Furthermore, there are not inconsiderable savings in potassium dichromate involved.

Field of application:

The ABL 35 process is used in place of the 5% dichromate process wherever the BA (formerly BS) process with its accompanying change in thickness is unsuitable for reasons of tolerance, i.e. mainly for fitted and threaded parts made from Flw. 3510. Although this process offers no advantages with Flw. 3501 over the method used hitherto, it may also be used for the small number of fitted and threaded parts made from 3501.

Bath equipment:

Existing bath equipment is to be used; only the current bath contents are to be changed. Attention should be paid to the higher temperature.

Operating instructions:

Operating instructions are to be obtained from the manufacturer of the chemicals.

Existing stocks of chemicals used hitherto for the dichromate process should as appropriate be offered for sale to Messrs. Frohen.
Supplier: Messrs. Dr. W. Frohen, Chem. Works, (13a) Kitzingen/Main, Post Box 44

Approval of bright zinc baths of Messrs. Hasse & Co
In addition to the bright zinc baths used hitherto, the HM, HM neu and Rekord baths of Messrs. Hasse & Co, Electro-Chem. Works, (IC) Heidnau near Dresden, have been approved.

Operating instructions etc. are to be obtained from the manufacturer.

p.p.
signed Hennings

Passed by:
Hoppe,
Aircraft Staff Engineer

SAMMELMITTEILUNG 2

Sammelmitteilung 2 [Collective Communication 2] is reproduced in its entirety below:

Supreme Command of the Luftwaffe
Head of Technical Aviation Equipment
E 10 No.239/44 (IV E) Ref. 70 K 10

Berlin W8, 15 August 1944
Leipziger Straße 7
Tel.: 218011
Ext.: 4535

F.A.O. all aircraft manufacturers, licensed producers and repair shops, and their production managements

Introduction of Night Camouflage Paint Flw. 7126.22

In place of the night camouflage paints Flw. 7123.99 and Flw. 7124.22 (permanent night camouflage finish) used hitherto as per L.Dv. 521/1 P. 20/21 and P. 42, the permanent night camouflage paint

Flw. 7126.22

is being introduced.

Intended use and field of application.
Flw. 7126.22 is a single-layer permanent camouflage paint which is to be applied, in accordance with the camouflage drawing, on to the existing finish (e.g. Flw. 7121).

Application instructions.
Flw. 7126.22, which is supplied as a thick paint, is to be diluted with paint thinner 7205.00 at a ratio of 2:1 so that its viscosity measured in a 4mm dia. DIN bowl is approx. 13.5 sec. It is sprayed evenly without misting over the existing paintwork at 3.03 bar using a 2 to 3mm dia. nozzle. In series production Flw. 7126.22 can already by sprayed on ½ to 1 hour after Flw. 7121 has been applied. It is dust-dry after 40 mins, transport-dry after 2 hours.
With older aircraft the existing paintwork has first to be cleaned with the stipulated alkaline cleaning agent (organic cleaners are prohibited for this purpose), then washed and dried before applying the night camouflage paint.

Attention! The paint has to be properly stirred so that all the pigments which create the camouflage effect are evenly distributed!

Markings.
In respect of the marking of aircraft for night operations, sect. V on p.18 of L.Dv. 521/1 remains in force.

Supplier: Dr. Fritz Werner, Berlin-Oberschönweide, Fuststr. 1-25, tel. 633232

Existing stocks of Flw. 7124.22 are to be used up if possible.

Introduction of Re-camouflaging Paint Flw. 7126.76

In place of Flw. 7125.65 (see L.Dv. 521/1, sect. G.S. 41/43.)

In place of Flw. 7125.65 the re-camouflaging paint

Flw. 7126.76

is being introduced.

Intended use and field of application.
The blue re-camouflaging paint is used to re-camouflage aircraft from permanent night camouflage to day camouflage.
Application instructions.
The aircraft is to be cleaned with the stipulated alkaline cleaning agent (organic cleaners are prohibited for this purpose). After drying the ready-to-use Flw. 7126.76 is painted in the direction of flight over the existing camouflage, with the national markings being left untouched. Masking of these areas with masking tape or similar is unnecessary, as the paint is applied by brush. The paintwork is dust-dry in 40 mins, transport-dry in 2 hours.
Supplier: Dr. Fritz Werner, Berlin-Oberschönweide, Fuststr. 1-25, tel. 633282

Note: Flw. 7126.76 is for use primarily by front-line units.

Introduction of Aircraft Primer 7270.99

As stated in the regulation of 30.5.44 concerning extreme simplification of surface protection, aircraft primer 7270.99 is being generally introduced to replace all other primers used hitherto. However, this aircraft primer is only to be applied to fighters, Zerstörer and other aircraft yet to be specified.
The primer is applied directly on to sheet metal without any other base coats. The only prerequisites are that the sheet has been cleaned and degreased.

Replacing Flw. 7101.02 by Flw. 7101.66

Flw. 7101.02 was specified for painting aircraft interiors. But as the interior paintwork of metal aircraft is largely no longer applied, due to the substantial simplification of aircraft interiors, and as the main require-

ment in paint is for antiglare purposes in the cockpit, namely in shade 66, the following has been stipulated for reasons of simplification in stock-keeping and rationalisation in the paint industry:
Aircraft paint 7101.02 is uniformly replaced by aircraft paint 7101.66
Future orders of Flw. 7101 should only be placed for shades 66 or 99 (as undercoat for 2-layer systems). The paint industry has been instructed to produce Flw. 7101 only in the shades 66 and 99. Existing stocks are to be used up.

Camouflage

Camouflage colour shades and their distribution over the aircraft have been uniformly redefined. The companies responsible for providing camouflage drawings will receive a camouflage guide with the required information from the Travemünde Test Centre. With the issue of this camouflage guide the industry is expressly forbidden to use any other camouflage types or colours, e.g. in response to special requests from front-line units, than those specified in the camouflage guide, unless specifically authorised by the Travemünde Test Centre.
As a result of this new regulation the following RLM shades are in future to be discontinued: 65, 70, 71 and 74. Shade 70 continues to be specified solely for propellers.

Directive concerning Extreme Simplification in Surface protection of Fighters and Zerstörer

Re. GL/C-E 10 IV, ref. 70 k 10 Hr. 4135/44 of 30.5.44

The above directive contains a typing error on page 3. Aircraft paint 7106.66 should read aircraft paint 7101.66

Discontinuing, or Extreme Economising in,

Solvents used as Cleaning Agents

In the provisional regulation B.No. 238/44 governing metal parts, assemblies and complete aircraft, alkaline cleaners are specified not only for cleaning components, sheet metal, sections etc. but also for cleaning and degreasing assembled (riveted, welded etc.) parts. Tests have proven that fears concerning the development of corrosion from cleaner residue are unnecessary, especially in view of the current short lifespan of aircraft. This general authorization and introduction of alkaline cleaning agents in place of organic solvents considerably eases the pressure in the solvent sector, which in turn benefits paint production. For this reason, any additional man-hours which might arise have to be accepted. Trials in aircraft factories have shown that with appropriate work restructuring this extra expenditure is hardly noticeable.
A ban on the use of organic cleaners, such as aircraft cleaners Z, Per, Tri, benzene or other cleaning agents offered by the chemical industry, is herewith officially announced. Obviously, the use of aircraft paint thinners is also prohibited. In cases where the use of solvent cleaners Z or Per is unavoidable, a suitable application for approval should be directed, via the Travemünde Test Centre, to GL/C-Pr V B.
Trials with other alkaline cleaning agents are currently in progress, information on these will be published at the appropriate time. To prevent misunderstandings it is pointed out that the use of Siliron WL for the purpose specified in L.Dv. 521/1, p.39-40, has not been revoked or prohibited by the issuing of the provisional regulation of 12.5.44, but continues to be permissible.

Savings Representatives for Paint etc.

The reports sent in reply to the letter: The Savings Commissioner of the Luftwaffe GL/C-E 10 No. 506/43 (IV E), ref. 70 k of 30.9.43, in which the names of savings representatives nominated by the factories were given, have been destroyed. We request that this report be repeated and addressed to the Travemünde Test Centre E21.
Deadline 15.4.44
It is requested that all collective communications be forwarded to the savings representative.

National Insignia

It has been noticed that despite various orders concerning simplification, saving measures etc. Balkenkreuze and swastikas are still being applied in the original fashion.
With Balkenkreuze only the angles, in the case of swastikas either the black area or the white surround only are to be painted, namely on the
Light shades 76 and 21 only the black angles of the Balkenkreuz and the black swastika, on the dark shades 72, 73, 75, 81, 82, 83 only the white angles of the Balkenkreuz and the white surround of the swastika.
This directive also applies if transfers or decals are used; existing stocks are obviously to be used up. However, future orders should be placed in line with the above; shade 21 for the angles and surrounds is replaced by shade 77 grey in the case of night camouflage paintwork in shade 22 (see L.Dv. 512/1 p. 18).
The savings representatives are to be made aware of this reminder.

Aircraft Material Marking

Various incidents have given cause for pointing out that the aircraft material markings of semi-product manufacturers, as well as manufacturers' markings, should not be removed in order to ensure that the prescribed material can always be identified.
Some bleeding of the markings, particularly in con-

nection with the light camouflage shade 76, is no cause for complaint! For this avoids attention having to be paid during the cutting of panels to the correct position of the marking, i.e. on the inside of the aircraft. It is requested that the Travemünde Test Centre E21 be informed of the names of semi-product manufacturers whose products have exhibited such bleeding so that the former can initiate a change in the marking paint.

Non-flammable Dope 7137

The non-flammable dope 7137 is supplied in two shades, namely 99 (in this case approx. oxide red) and 26 = oxide brown. These dopes tauten at different rates. Under normal working conditions (see L.Dv. 521/1, p. 34, sect. D 4 c 4) Flw 7137.99 is to be used; while Flw 7137.26 is to be used under the following exceptional conditions: when working on large-capacity components with good interior ventilation either in well-ventilated workshops (open doors) or completely outdoors.

Flw. 7137.26 prevents rapid tautening and thereby irregular tensioning, because it tensions more slowly than Flw. 7137.99. But under the given conditions it achieves the same drying time as Flw. 7137.99. In cases where Flw. 7137.99 has a tendency to develop the well-known white bloom when exposed to high humidity coupled with fast external air changes, particularly with narrow components, then in place of aircraft paint thinner 7213.00

Flw. 7213.00 "Retarder Quality"

is to be used. This thinner will not be allocated a new Flw. Number as it is only rarely required. If necessary, it should be ordered as

Flw. 7213.00 "Retarder Quality"

from the supplier Messrs. Herbig – Haarhaus – Köln, or their licensees. Flw. 7137.26 is not used by service personnel.

Aircraft Paint 7114

(Intermediate Paint for Non-flammable Aircraft Paint System 05)

Due to the limited allocation of aluminium bronze, aircraft paint 7114.01 has had to be changed to Flw. 7114.99. Because of the low aluminium content its colour is only light grey.

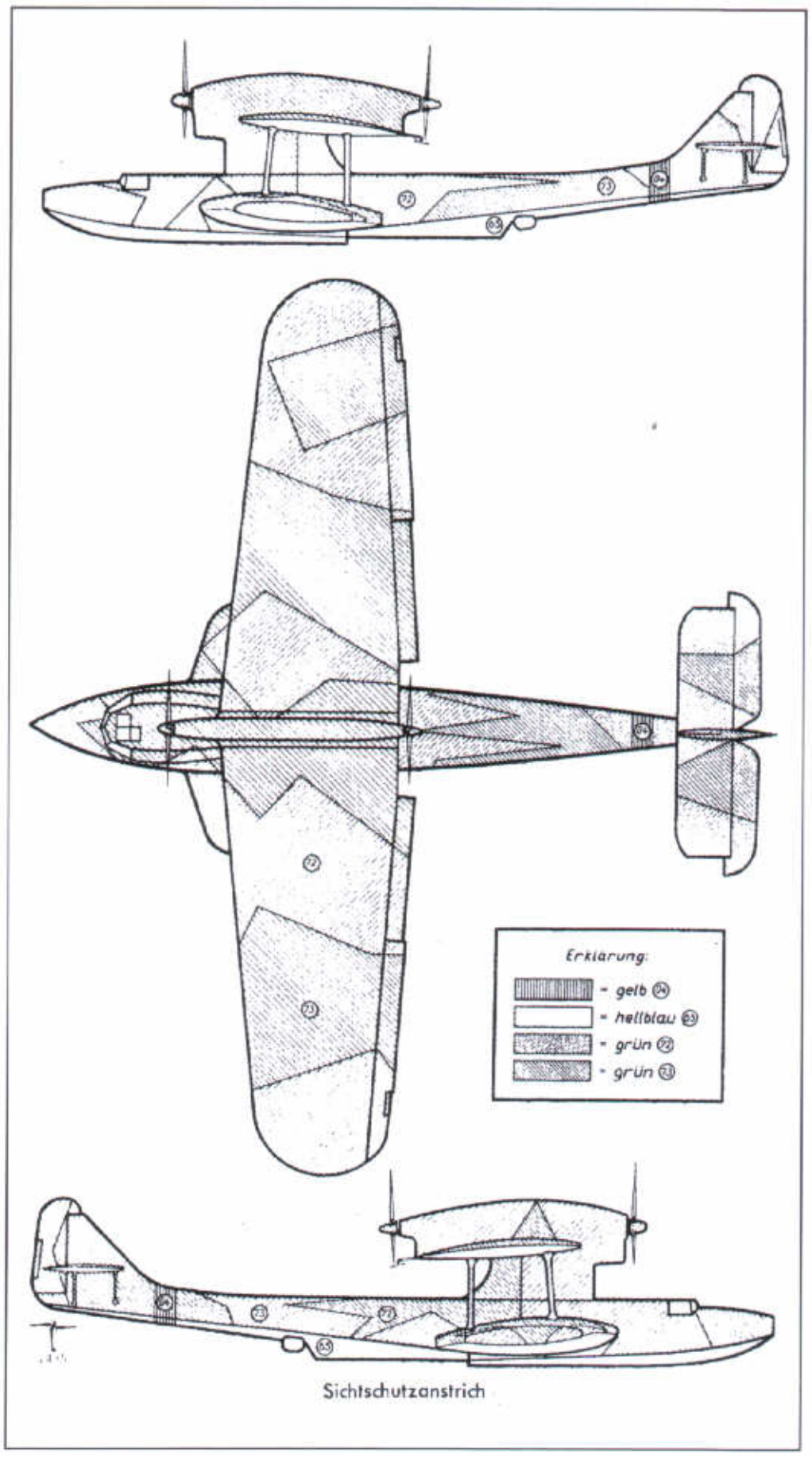
Intermediate paint 7114 is henceforth only to be ordered as

Flw. 7114.99.

Application and processing is the same as with Flw. 7114.01.

p.p.
signed Hennings

Passed by:
Hoppe, Aircraft Staff Engineer



366 Above: *This is the camouflage pattern for the Dornier Do 18, taken from the aircraft handbook. Similarities between the pattern for this aircraft and that for the Do 24 shown on page 86 will be apparent. Close study of the splinter patterns on all Luftwaffe aircraft will show certain elements which are common to nearly all; for instance the sawtooth detail on the fuselage spine and a large rectangular area on one wing, usually the starboard. It should be recognised, however, that mirror image patterns existed and colours could be interchanged*

RLM COLOURS

Gruppe	RAL-Ton	Besonderes	Nr. im RAL Reg. 840 R
Wehrmacht:			
Heer:	Rotbraun 13/840 B 2	matt	8013
	Hr'lgrau 2/840 B 2	„	7009
	Gelb 23/840 B 2	„	1006
	Feldgrau 3/840 B 2	„	6006
	Dunkelgrau 46/840 B2	„	7021
	Erdgelb 17/840 B 2	„	8002
	Grün 28/840 B 2	„	6007
	Braun 18/840 B 2	„	8010
	Dunkelbraun45/840B2	„	7017
	Rot 7/840 B 2	„	3000
	Elfenbein 20m/840 B 2	„	1001
	Blau 32/840 B 2	„	5001
	Fliegerblaugrau 4/840 B 2	„	7016
	Gelbrot 25/840 B 2	„	2001
	Gelbrot 2006	„	2006
	Beige 15 h/840 B 2	„	1002
	Graugrün 7027	„	7027
	Gelbbraun 8020	„	8020
	Weiß 1/840 B 2	„	9002
	Schwarz 5/840 B 2	„	9005
Luftwaffe:			
Flugzeuge	Hellgrau 1 r/840 B 2	Farbtöne nach	7003
	Dunkelbraun 61	eigener Farben-	8019
	Grün 62	karte der Luft-	6002
	Hellgrau 63	waffe (LDv 521/1)	7004
	Hellblau 65		
	Schwarzgrau 66		7019
	Schwarzgrün 70		
	Dunkelgrün 71		
	Grün 72		
	Grün 73		
	Dunkelgrau grünlich 74		
	Mittelgrau 75		
	Lichtblau 76		
Sonstiges	Wasserhell 00		9000
	Silber 01		9006
	RLM-Grau 02		7003
	Gelb 04		9004
	Weiß 21		9001
	Schwarz 22		9004
	Rot 23		3001
	Dunkelblau 24		5000
	Hellgrün 25		6000
	Braun 26		8004
	Gelb 27		1003
	Weinrot 28		3008
Kriegsmarine:			
Schiffe und Fahrzeuge	Dunkelgrau 1		7016
	Dunkelgrau 2		7024
	Dunkelgrau 3		7000
	Hellgrau 4		7001
	Rotbraun 5 (Kaiserrot II)		8013
	Kaiserrot I 6		3002
	Luxrot 7		—
	Schwarz 8		9005
	Blau 9		5004
	Braun 10		8011
	Grün (Chromgrün) 11		6005
	Ockergelb 12		1011
	Gelb 13		1003
	Weiß 14		9002
	Elfenbein 15		9003
	Aluminiumbronze 16		9006

This chapter contains lists of shades used together with their designations and cross-references to the RAL shades still available today.

How were the present results arrived at?

To give every modelmaker an opportunity to follow the recommendations made here, a description of the way in which this was done follows. Many of the RAL-colours indicated are not commercially available. They must be specially mixed to order. In this case, a large majority of the RAL colours was produced with a Sikkens Shade Automat. The machine was equipped with Matchpoint 3.1 software.

This is stated precisely simply because the same results will not be achieved should another manufacturer's machine be used. This statement is based on the fact that every colour is composed of the three basic colours red, green and blue. However, many roads lead to the same result. If, in fact, a manufacturer other than Sikkens uses a different mixing ratio for the three basic colours, a different result may be achieved when mixing with the colours indicated.

A number of the shades described cannot be imitated from the RAL Listing without major problems since the original shades were deleted from the Listing during the reorganisations. Fortunately, recent processes permit us to imitate these shades. Sikkens can imitate a large number of shades using their Shade automat. These shades can be identified by a number sequence (e.g. F6.30.70). For various shades, this sequence of numbers can be indicated in the RAL number box and the shade can then be ordered by using this number sequence.

The list of standard paints on the left has been taken direct from the "Paint-shop Handbook (1944)". Note that it contains a number of printing errors: the RAL number for RAL Yellow [Gelb] 04 is not 9004 (this would be a black) but 1004; the RAL number for Green [Grün] 62 is 6003 and not 6002.

Notes to the chart opposite:

1. The majority of documents available always list the shade only as a number (76 or 81), designations being used as well in only very few cases. It is believed the reason is that terms were adopted in everyday use which in some cases entered the OS Lists since the RLM used only the numbers and not the shade designations.
2. No original documents have been found for shades 77 and 83 which confirm the designation of these colours. The designations used are those appearing in the relevant literature.
3. Shade 84 never existed. It would appear that this designation was created by other post-war writers to explain the light underside variants of colour RLM 76.

Listing of RLM Paints and their Designation

RLM No.	Designation	Data Origin
00	Wasserhell / Water-white	L.Dv.
01	Silber / Silver	L.Dv.
02	RLM Grau / RLM grey	L.Dv.
04	Gelb / Yellow	L.Dv.
05	Elfenbein / Ivory	L.Dv.
11	Grau / Grey	L.Dv.
21	Weiss / White	L.Dv.
22	Schwarz / Black	L.Dv.
23	Rot / Red	L.Dv.
24	Dunkelblau / Dark blue	L.Dv.
25	Hellgrün / Light green	L.Dv.
26	Braun / Brown	L.Dv.
27	Gelb / Yellow	L.Dv.
28	Weinrot / Wine red	L.Dv.
41	Grau / Grey	L.Dv.
42	Grau / Grey	L.Dv.
61	Dunkelbraun / Dark brown	Dornier
61	Braun / Brown	L.Dv.
62	Grün / Green	Dornier
62	Grün / Green	L.Dv.
63	Hellgrau / Light grey	Dornier
63	Grau / Grey	L.Dv.
64	Dunkelgr n / Dark green	L.Dv.
65	Hellblau / Light blue	L.Dv.
66	Schwarzgrau / Black grey	L.Dv.
67	Weiss / White	L.Dv.
68	Schwarzgrün / Black green	L.Dv.
69	Dunkelgrün / Dark green	L.Dv.
70	Schwarzgrün / Black green	L.Dv.
70	Dunkelgrün / Dark green	Messerschmitt
71	DunkelGrün / Dark green	L.Dv.
72	Grün / Green	L.Dv.
72	Mittelgrün / Middle green	Dornier
73	Grün / Green	L.Dv.
73	Dunkelgrün / Dark green	Dornier
74	Dunkelgrau grünlich / Greenish dark grey	Paint-shop Handbook 1944
74	Graugrün / Grey green	Messerschmitt
75	Mittelgrau / Middle grey	Paint-shop Handbook 1944
75	Grauviolett / Grey violet	Messerschmitt
76	Lichtblau / Light blue	Paint-shop Handbook 1944
76	Lichtblau / Light blue	Messerschmitt
77	*Hellgrau /Light grey*	
78	Hellblau / Light blue	Aircraft painter 1944
79	Sandgelb / Sand yellow	Aircraft painter 1944
80	Olivgrün / Olive green	Aircraft painter 1944
81	Braunviolett / Brown violet	Messerschmitt
81	Olivbraun / Olive brown	Blohm & Voss
81	Dunkelgrün / Dark green	Dornier
82	Hellgrün / Light green	Messerschmitt
82	Hellgrün / Light green	Blohm & Voss
82	Dunkelgrün / Dark green	Dornier
83	*Dunkelgrün / Dark green*	
91	Duralgrau oder Dunkelgrau / Dural Grey or Dark Grey	Lufthansa
99	The figure 99 indicates that the actual shade or its accuracy is unimportant.	L.Dv

Sources

- *Handbuch der Lackierbetriebe*, 1944 Edition, Hans Weise. Now only available for inspection on file
- *Rezeptbuch für die Farben und Lackindustrie*, 1943 Edition, Hans Hadert. Now only available for inspection on file
- *Works Circular Blohm & Voss of 13.9.1944*, Blohm & Voss. Now only available for inspection on file
- *Oberflächenschutzliste Do 24 K*, Date 4.10.1937, Dornier Now only available for inspection on file
- *Aircraft manual for Do 17 E*, Dornier. Now only available for inspection on file
- *Supplement to Amendment 10/44 for Ju 188*, Junkers. Now only available for inspection on file
- *Herbig-Haarhaus AG Lackfabrik*. Erkner Works letter of 29.1.1945 concerning the Salamander Program 8-162 to Messrs Robert Hartwig, Sonneberg, Herbig-Haarhaus AG. Now only available for inspection on file
- *"With the Dornier Flying Boat Do 18 Zephir over the North Atlantic"* by Flugkapitän Joachim Blankenburg 1936.
- *Dornier Post*. Now only available for inspection on file
- *Letter* from Lufthansa, Travemünde of 27.9.1938 to the South Atlantic District Management, Las Palmas, Lufthansa. Now only available for inspection on file
- *Lufthansa South Atlantic District Management* in Las Palmas of 19.8.1937. Lufthansa. Now only available for inspection on file
- *Composition of the chief paints kept by DLH and their purpose*. Status 1.11.1936, Lufthansa. Now only available for inspection on file
- *Quarterly report by the Engineering Control* for July to September 1940 and for April to June 1941, Lufthansa Now only available for inspection on file
- *Sammelmitteilung 1* of July 1944, RLM. Now only available for inspection on file
- *Sammelmitteilung 2* of 15.8.1944, RLM. Now only available for inspection on file
- *HM Notice No. 7/42* simplifying surface protection for land aircraft of 18.5.1942, RLM. Now only available for inspection on file
- *Circular to all aircraft development, production and repair works and their construction supervisors ref. 70 R* 10.11 GL/C-E 10 No. 4135/44 (IVE) of 10.3.1944, RLM Now only available for inspection on file
- Various editions of the Luftwaffe regulation sheets, RLM. Now only available for inspection on file
- *Der Flugzeugmaler* (The Aircraft painter) 1939 Edition RLM. Now only available for inspection on file
- *Der Flugzeugmaler* (The Aircraft painter) 1944 Edition RLM. Now only available for inspection on file
- *Application and processing instructions for RLM camouflage paints* (building and ground camouflage) 1941 RLM. Now only available for inspection on file
- *DIN L 5* 'Distinguishing colours for pipes and hoses', May 1941 edition, DIN. Still available! Price DM 27.20 from Beuth Verlag GmbH Burggrafenstr. 6, 10787 Berlin
- *L.Dv 521/1 Draft treatment and application instruction for aviation lacquers (with colour chart)*, 1938 edition., RLM. Now only available for inspection on file
- *L.Dv 521/1 Handling and application instruction for aviation lacquers (with colour chart), Part 1: Flying machines, November 1941*, RLM. Now only available for inspection on file
- *L.Dv 521/2 Handling and application instruction for aviation lacquers (with colour chart), Part 2: Sailplanes, November 1943*, RLM. Now only available for inspection on file
- *L.Dv 521/3 Draft regulation for repairing aircraft lacquering 1937*, RLM. Now only available for inspection on file
- *Guideline for developing suitable aviation lacquers* (with colour chart). Issue date unknown. Now only available for inspection on file

367: *A superb view of the engine and propeller of an Fw 190A which clearly shows the 30mm unpainted section at the root of each blade to allow checking for blade adjustment (see page 247). It also shows the white spiral on the black painted spinner. This was in accordance with the order of 10 February 1944 which stipulated that all fighter aircraft of Luftflotte 3 and Luftflotte Reich were to have such a marking. See page 173*

LUFTWAFFE COLOURS 1935 -1945

HIKOKI PUBLICATIONS

RLM 02 RLM Grau

RLM 04 Gelb

RLM 21 Weiss

RLM 22 Schwarz

RLM 23 Rot

RLM 27 Gelb

RLM 28 Weinrot

RLM 62 Grün

L40/52 Hellgrau*

RLM 65 Hellblau (1941)

RLM 66 Schwarzgrau

RLM 70 Schwarzgrün

RLM 71 Dunkelgrün

RLM 75 Mittelgrau

RLM 76 Lichtblau

RLM 79 Sandgelb

RLM 82 Hellgrün

RLM 83 Dunkelgrün

LUFTWAFFE COLOURS 1935 -1945 (Supplement)

RLM 69 Dunkelgrün

RLM 70 Schwarzgrün

RLM 71 Dunkelgrün

RLM 72 Dunkelgrün

RLM 76b (Variation)
Graublau

RLM 79 Sandgelb

RLM 80 Olivgrün

RLM 81 Dunkelgrün / Olivbraun

RLM 82 (Variation) Hellgrün

RLM 83 (Variation) Dunkelgrün

Shortly after the main paint chart had been produced, newer information revealed that colours 69, 70, 71, 72 and 76b were inaccurate. The correct shades are shown here. 79 and 80 had been actually matched to Italian shades. The correct German colours are here. The shade identified as 81 Dunkelgr,n on the larger chart is actually 81 Braunviolett; that shown as 81 Braunviolett is a variation. The remaining 81, 82 and 83 shades here are also variations.

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Paint chips by Matherson SPA, Bergamo, Italy